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ABSTRACT

This teaching guide provides an integrated framework for teaching thinking skills which involves both teaching thinking in a separate program or course and infusing the teaching of thinking into standard subject area instruction across the curriculum. Individual chapters deal with the following topics: (1) the nature of thinking skills and evidence that people can learn to think better; (2) the improvement of thinking; (3) kinds of thinking (broad categories, specialized kinds of thinking, metacognition, and some thinking frameworks); (4) the infusion of teaching thinking into regular subject-area instruction; (5) choosing and using separate instructional programs designed to teach thinking; (6) program development and selection of thinking skill goals; (7) lesson design and instructional strategies (structured thinking, teaching for transfer, and metacognition); (8) support systems for teachers and schools in the teaching of thinking; (9) approaches to evaluation; and (10) types of tests (objective and interpretive). (Individual chapters contain references.) (DB)

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THE PRACTITIONERS' GUIDE TO TEACHING THINKING SERIES

TEACHING THINKING: ISSUES & APPROACHES

Robert J. Swartz & D.N. Perkins

Midwest Publications

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Robert J. Swartz & D. N. Perkins

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FOREWARD

Teaching for thinking has become a major agenda in schools across this country. No one, of course, doubts that in the past educators have been concerned about the quality of student thinking and have worked to improve it. Such attempts, however, have all too often fallen prey to the pressures for coverage and for learning factual information with which all teachers have to cope. Today, by contrast, teachers in many schools are learning to manage—and even modify—the demands of coverage while emphasizing the development of forms of thinking that foster learning, understanding, and critical and creative thought. This shift reaffirms the value we place on good thinking. It also underscores the need not only to continue with these attempts but to turn more of them into greater successes. It is in this spirit that we offer a series of reflective guides for educational practitioners. We believe that enough is known today about thinking and how it can be taught to put into the hands of practitioners guide books that synthesize the relevant work of leaders in this field. This series presents a systematic conception of the aims of teaching for thinking and guidelines for achieving these aims in interactions with our students.

There is a second, less upbeat reason for publishing these volumes. Like any major shift in institutional priorities, the boom in efforts to explicitly teach thinking has provoked a wide variety of disparate approaches, claims, and advocates. They all tell us what we should be aiming at in teaching thinking and how best to do it. Often, however, hidden beneath the use of more or less the same terminology are quite different goals and means. While there is a sense in which such a ferment is healthy in a young field, the danger of fadism, miscommunication, and superficiality looms large, especially when there are pressures for immediate change and publishers are eager to respond.

It is our conviction that good thinking can be taught as a normal and comfortable element of educational practice. However, this mission cannot be accomplished overnight. It requires the very same good thinking and good sense that we all espouse as goals for our students. Thus, there is a need to stand back from the details of different methodologies and develop a broader perspective in which we tolerate a multiplicity of approaches while at the same time acknowledging a common basis lodged in a clear concept of good thinking and in a set of sound principles for teaching thinking that virtually all well-founded efforts should reflect.

We have created this series as a context in which these common goals and principles can be set out in order to provide practiced guidance to the classroom teacher and school administrator. They are the ones who have to make choices about how to implement the goal of developing students' thinking. But they do not have the time to probe the research in detail or travel around the country familiarizing themselves with approaches that claim success. Where there are basic alternatives for the teacher set against this common backdrop, these are spelled out and their scope and limits clarified.

The original concept for this series developed out of the first in a succession of annual faculty seminars sponsored and supported by the Critical and Creative Thinking Program at the University of Massachusetts at Boston, held in the summer of 1985. The participants in the seminar were:

Joan Baron	Conn. State Department of Education
Rebecca van der Bogert	Groton (MA) School System
Arthur Costa	Sacramento (CA) State University
Robert Ennis	University of Illinois
Bena Kallick	Weston Woods Foundation
Arthur Millman	University of Mass. at Boston
Stephen Norris	Memorial University of Newfoundland

Richard Paul	Sonoma State (CA) University
David Perkins	Harvard University
Linda Phillips	Memorial University of Newfoundland
Stephen Schwartz	University of Mass. at Boston
Alma Swartz	Westford (MA) School System
Robert Swartz	University of Mass. at Boston
S. Lee Winocur	Costa Mesa (CA) School District
Mary Anne Wolff	North Reading (MA) School System

While the ideas developed in these books are the authors' own, their root source and the motivation for the volumes derive from this seminar. We thank all the participants for their contributions to the development of each of these volumes. We are all dedicated to making good teaching of good thinking happen in our schools and to promoting the use of the very same good thinking on the part of professional educators as they plan and carry out this teaching.

ROBERT J. SWARTZ, FOUNDER
CRITICAL AND CREATIVE THINKING PROGRAM
UNIVERSITY OF MASSACHUSETTS AT BOSTON, AND

D. N. PERKINS, CO-DIRECTOR
PROJECT ZERO
HARVARD UNIVERSITY

GENERAL EDITORS

PREFACE

In *Teaching Thinking: Issues and Approaches,* we have attempted to provide for the educational practitioner an overview of a field that has responded in the 1980's to a major educational agenda. This innovative "agenda" calls for teaching students in ways that dramatically improve the quality of their thinking. Its context is a variety of changes in education that have brought the explicit teaching of thinking to the consciousness of more and more teachers and administrators. These are manifested through

- the adoption by states, local school boards, and individual schools of the teaching of thinking as an explicit educational goal;
- the incorporation of more and more references to and activities in thinking in educational materials, including textbooks; and
- the restructuring of standardized tests—from third grade state tests to the Graduate Record Examination—to incorporate attempts to test for good thinking.

We want to stress that while many books in this field have been written for researchers, we write this one to provide guidance for the educational practitioner. There are many different approaches and practices promoted in this field today. A number of these appear to compete with each other: many are set out as *the* exclusive approach to adopt if one is to accomplish the overall goal of teaching thinking well. Our job in writing this volume has not been to embrace any of these particular approaches and promote it as the sole vehicle for teaching thinking. Rather, it has been to help practitioners think through a number of important questions themselves about the teaching of thinking as represented in these approaches. For example, what is behind those often-used catch words, such as "critical thinking," "higher-order thinking," "thinking skills," and "metacognition"? Are these the forms of thinking that it is important to teach? What can be done

in standard subject-area instruction to promote good thinking? Are teachers doing any of these things already? What can be relied upon to help determine whether an approach to teaching thinking is working?

We in no way wish to attribute blame to teachers for the lack in general of teaching thinking in the schools. There is virtually no preparation for teaching thinking provided in most teacher-education programs. And while on the job, much of the time teachers are subject to pressures from the outside to raise the scores of their students on factually oriented tests that they have no control over and to cover a certain amount of material in texts they do not choose themselves. Even the most well-intentioned teachers yield to these pressures.

In this volume we develop what we believe to be a useful and comprehensible framework within which we locate these different approaches. The purpose of this is so that readers can easily understand what they should expect—and not expect—if they adopt one or another of these. We indicate what current research shows and what questions remain unanswered on the major issues about the teaching of thinking.

In particular, we begin this book with a discussion of what has generated the problem about teaching that these new approaches address. We suggest that the concerns are important and that they are manageable, but that they require a concerted effort on all our parts to address. No passing fad can meet them.

In looking at what this concerted effort can involve, we make use of what we know about thinking and how it is learned as a way of setting the backdrop against which endeavors in the field must be developed and weighed. For example, what do we know about thinking itself that allows us to conceptualize it in a comprehensive way—a way that is useful in articulating the details of our common goal of teaching good thinking? What do we know about human development that has bearing on how we relate to students in school classrooms in trying to accomplish our goals? What do we know about how thinking is learned that indicates which modes of instruction are liable to be most effective

in helping students assimilate into their lives the forms of thinking we are trying to teach them? How can effective change take place in schools to incorporate significant teaching of thinking so that fadism can be avoided? And what do we know about evaluation that can be brought to bear on the special problems involved in assessing improvement in thinking?

To us, good thinking is, at its roots, something with which we are all familiar. We accomplish it at times when we make careful choices and solve problems effectively. It involves the use of keen critical skills and open creative exploration in which we call up and gather relevant information that we bring to bear on the issues with which we are grappling. It is motivated by and cast in a spirit of appropriate care and openness, on the one hand, and decisiveness on the other. The problem is that we do these things far less often than we can or should.

Fortunately, we can be taught to improve in our use of good thinking. To us, this is a matter of *organization* and the reflective use of standards of reasonableness. It calls upon us to discipline our thinking processes in certain ways so that we draw upon and use information well in thinking things through in whatever we are thinking about. This applies equally to traditional subject-area content as we find it in history or in the natural sciences, as well as in comprehending great fiction, art, and music, or in producing our own more modest written, artistic, or musical products. But it also applies to more everyday thinking endeavors we go through in our lives—thinking that usually blends a variety of content knowledge across disciplinary and more practical boundaries. When purchasing a stereo or a car, or deciding how to relate to a family member who has a serious illness, organized forms of thinking in which we make maximum use of our thinking skills and relevant information are as important as they are in doing the most complex historical or scientific research. Teaching good thinking in ways that are assimilated into students' thinking in all of these settings is an overarching goal that we endorse as the most comprehensive and valuable to embrace in education.

How can we be most effective in teaching to maximize the potential we all have for good thinking? We discuss two basic approaches in this book that are sometimes presented as exclusive, but that we argue are not: (1) teaching thinking in a *separate* program or course either in school or in college; or (2) *infusing* the teaching of thinking into standard subject area instruction across the curriculum. These discussions are organized to help practitioners appreciate the scope and limits of these approaches, to make wise choices of programmatic approaches to adopt, and even to undertake constructing their own—whether separate programs or infused lessons. Since it is our feeling that a look at actual examples representative of these approaches is crucial in understanding their import, how they are constructed, and how they can be used, we have structured our discussion using something of a case-study approach. For this we are indebted to Kevin O'Reilly, Sandra Bostwick, Cathy Peabody, Cathy Skowron, Linda Sartorelli, and the teachers and administrators from the Bedford and Provincetown, Massachusetts, school systems, whose work we refer to in this book, as well as the myriad of other educational practitioners from whom we have learned much about the realities of teaching thinking in the classroom.

Three interrelated issues that grow out of our overview of ways of infusing teaching for thinking into standard subject area teaching and of stand-alone programs are discussed in the remaining chapters of the book. We consider in some detail what we can do to teach these forms of thinking effectively in the classroom, whatever curricular approach is adopted. We examine how the professionals in a school community—the teachers and administrators—can work effectively within the structure of the school community to bring a major emphasis on thinking into the curriculum. Again, this can happen whatever particular approach to the role of thinking *vis-à-vis* the rest of the curriculum is adopted. And finally, we consider what we know about assessment that can help us to make wise choices in how we determine whether we are succeeding and indeed whether students are improving in the way they think. We view approaches to these

as matters of design involving both the science and artistry of the educational practitioner.

This volume is written as an overview through which it will not take readers months to plod. For this reason, it was chosen to serve as the lead volume in a series in which other volumes will elaborate aspects of its basic content in more depth and detail than could be accomplished in this book. Our message to educational practitioners in writing this volume—indeed in the whole series—should be a clear one. It is through your own discriminating thought and choices, based on *your* use of constructive critical and creative thinking, that we can avoid the fadism and sloganism of past movements in education. Further, this time we can incorporate what is valuable in this new emphasis on thinking into our lives as professionals and into our educational institutions in a lasting way. We hope this volume helps you begin this process.

CHAPTER ONE

PROMISE AND POSSIBILITIES

Education designed to develop thinking has become exciting and challenging for many practitioners and others concerned with schooling. The historical reasons for this turn of events will be explored a little later, but one certainly must honor the boldness of those who feel drawn to this mission. After all, of the many human activities that we value—athletic, artistic, diplomatic, economic, and so on—good thinking viewed as a general skill seems one of the vaguest and least amenable to schooling. Yet the prospects for education designed to improve students' thinking are very real and worth careful consideration by any educator who feels drawn to the promise and possibilities of this mission.

As we face the prospect for developing students' thinking, many questions inevitably arise. Our healthy internal skeptic alerts us to a number of concerns. What is meant by "thinking" and what would "*better* thinking" mean? Why is the teaching of thinking popular today? Is this yet another educational bandwagon that will eventually falter and fail? Good schools and teachers have always taught thinking, have they not? Is there any evidence that people can learn to think better? What about the barriers of IQ and limits on the pace of human development? In this first chapter of the overview, we examine such questions and offer some optimistic answers that add up to good prospects for the development of students' thinking.

What Is Meant by Thinking?

The short answer here is, "What you would think." While this answer is a little flippant, it carries an important message. People interested in efforts to teach thinking have some natural concerns about what this might entail. For instance, some programs designed to teach thinking emerge from university research and

might involve abstruse and obscure conceptions of thought. Fortunately, as we view the field as a whole, thinking really does mean "what you would think." The teaching of thinking as it occurs today includes virtually all of those diverse mental acts we ordinarily consider to be thinking.

For example, when we speak of thinking we often have in mind the problem-solving performances common in school: working math problems, reading to answer questions, writing an essay, and so on. These are common focal points in efforts to develop thinking. Sometimes we have in mind more ambitious sorts of thinking that regrettably do not appear in school settings as often as we would like: for instance, creative thinking that yields new ideas and critical thinking that seeks penetrating insights and assessments. These, too, receive direct attention from a number of programs and approaches to developing students' thinking. We may have in mind the sorts of thinking called for in everyday life: prudent decision making, forecasting possibilities, good judgment in practical matters. These receive attention from some approaches and programs. Without belaboring the matter further, let us make a generalization. The conception of thinking broadly apparent in the field of teaching thinking is just our everyday common-sense conception of thinking in all its diversity.

There is some reassurance in that answer. It implies that we need not fear that the movement to develop thinking includes a narrow or overly technical notion of its target. To be sure, one needs to look carefully at individual approaches and programs, asking whether they foster the sorts of thinking one wants, but such a concern does not arise regarding the overall enterprise.

We should confess that there is a harder version of the question, "What do we mean by thinking?" It might read, "What are the mechanisms of thinking?" This is an issue for psychologists, philosophers, and others probing the nature of the mind, and inevitably different answers emerge from different experts. Some approaches and programs designed to develop thinking do not involve a very technical conception of thinking; others do, and often

rather different conceptions. So, while the harder version of the question is a good one, no answer generally acceptable to everyone in the field can be given. We can, however, offer a systematic and fairly eclectic framework. In the next two chapters, we will examine the nature of thinking in terms of such psychological elements as component processes, strategies, and attitudes. Meanwhile, we can be comforted that while experts sometimes disagree about how thinking works, they and the rest of us are talking about the same full range of human activities—what we ordinarily mean when we speak of thinking in its many guises.

What Is Meant by Better Thinking?

If we would like people to think better, we need to understand the nature of better thinking. In fact, the response to this question parallels the response to the previous question: taking the field as a whole, better thinking means by and large what it means in common-sense terms. No special or esoteric conception of better thinking enters. There is, however, some value in distinguishing between our everyday ideas about better thinking *outcome* and better thinking *processes*.

Often we conceptualize better thinking in terms of outcomes. Better thinking yields, for example:

- more reliable conclusions,
- deeper insights,
- sounder decisions,
- more finely crafted products,
- more creative inventions, and
- keener critical assessments.

Not only is this sensible and even commonplace, but it has immediate implications for schooling. Students cannot develop better thinking as gauged in terms of outcomes unless they engage in activities *with* those outcomes. For instance, students cannot hone their decision-making capabilities unless they engage in significant decision making. Yet schools typically afford little op-

portunity for students to confront and explore decisions as a routine part of the curriculum. Likewise, the visual arts and creative writing aside, schools offer little opportunity for students to produce creative outcomes. How, then, can they be expected to develop skills for creativity? To generalize, our everyday and commonplace notion of better thinking outcomes plainly goes far beyond what school settings usually accommodate.

Besides conceiving better thinking in terms of outcomes, we also speak of it in process terms. Better thinking, for example:

- considers more possibilities,
- explores farther and wider,
- exercises keener judgment,
- marshals more data,
- challenges assumptions,
- exercises precision,
- checks for errors,
- maintains objectivity and balance.

Indeed, these rough characterizations of process can be taken as informal theories of the origins of the *outcomes* of better thinking: better thinking is the result of better thinking processes. The processes, like the outcomes, carry an important message. If students are to develop their thinking, they must have opportunities to engage in the sorts of processes that make up better thinking. Conventional schooling does afford ample opportunities to exercise some of these processes, such as checking or maintaining precision; others, such as maintaining objectivity and balance, challenging assumptions, or exploring something deeply, are opportunities seldom found.

Why Is the Teaching of Thinking A Popular Endeavor Today?

Certainly the ebb and flow of enthusiasm for different educational agendas should surprise no one. It has long been a characteristic of the educational world. Because teaching thinking over

the past half-decade has become a popular mission for many educators, we need to ask why this has happened. Is it *just* ebb and flow—a natural cycle in the goals that engage the attention of the public concerned with education—or does something more substantive underlie the present enthusiasm?

The question particularly calls for attention since the teaching of thinking itself—never mind other educational innovations—has occupied the spotlight before. Many will recall the curriculum reform movement that recruited a number of scholars from diverse disciplines during the late 60's and early 70's. A number of projects that focussed on mathematics, the hard and social sciences, and certain of the humanities sought to introduce students to the processes of thought important in those subject matters—processes that all too often received little attention as students waded through pages of factual content. There were differences between then and now, to be sure. For one, this prior subject matter focus on the teaching of thinking yielded few stand-alone courses specifically *for* thinking such as those that now occupy a prominent position in the field. Nonetheless, a cautious educator remembering those times might well say, "Here we go again."

Then let us consider the key questions. Why *again*? Why *now*? Are we in a position to do any better this time around? When we think about the first question, it is important to remember that concern with developing students' thinking, far from being a fad, is one of the most persistent and ambitious aspirations of education, with a tradition stretching back at least to Plato. To be sure, this objective has not always been pursued, but it has been recurrently sought after in one form or another. There can be no question that, if current efforts to develop students' thinking succeed by contemporary standards, education will have taken another major step in a venerable quest.

But why *now*? Two intertwined historical trends deserve recognition. The first of these concerns the "back-to-basics" movement of the 70's. In part, this was a reaction to the ambitious curriculum reform attempts that came before; in part it was a re-

sponse to other factors, including the documented difficulties many students were encountering with basic skills of reading, writing, and arithmetic. Even in the heyday of the "back-to-basics" movement, some voices in the wilderness were warning that more than the sturdy trio of the three R's was basic. The reality of this prophecy gradually became clear in the ensuing years. Testing conducted by the National Assessment of Educational Progress and other agencies disclosed that in due course the basics were not faring too badly. Unfortunately, performance on "higher-order skills," as they were often called, left much to be desired.

Perhaps the greatest public alarm resulted from the observation that students performed *worse* on certain higher-order tasks than their peers of a decade before, for instance on certain sorts of mathematical problem solving. It seemed that some knack for rigor and reason had slipped away with the previous generation of students and teachers. But what was it? Student discipline? Sufficient challenge? Student ambition? The decline of teaching as an honored profession? In our view the heart of the problem lies not in the minor ups and downs of average scores over the years, but in the general level of performance then and now. The fact is that, today *and* a decade ago, students were performing far below what one would like to see in such areas as mathematical problem solving, critical and creative writing, and interpretive reading. This shortfall has come to the attention of the public not only through national testing programs but also through the several recent reports on the quality of primary and secondary education in the United States. While these reports did not particularly single out the teaching of thinking as a separate topic (and indeed, whether it *should* be a separate topic is controversial, as we shall see), they certainly did emphasize the imperative need for more attention to intellectual development.

A second strand from more academic sources also contributes to the current concern with development of thinking in classrooms. Numerous representatives of the disciplines of psychology and philosophy have found the arena of public education a

new laboratory for exploration and occasion for contribution to society. Over the past decade and more, psychologists have turned somewhat away from animal experimentation and the technical nuances of isolated bits of human behavior and turned toward the kinds of complex contextual conduct that have significance in the real world. Learning, problem solving, writing, and other performances important in academic settings have been among their favorite concerns. Many have spoken of educational settings as natural and fruitful meeting grounds for practical and theoretical interests. Moreover, consequent upon their efforts have been important advances in the contemporary understanding of mind. These advances put us in a better position today to plan intelligent approaches to developing students' intellect than was the case during the last swing of the pendulum.

Philosophy, too, has come out of the ivy to meet teachers and students in the corridors of schools. While most work by psychologists has emphasized learning, problem solving, and analytical thinking with a scientific slant, most work by philosophers has concerned critical thinking. It has highlighted good grounds for belief, judicious weighing of issues, and the like, and has exhibited a humanistic slant. As psychology has focussed on building instructionally relevant and empirically confirmed models of the nature of mind, philosophy has focussed on equally important analytical and normative issues. It is perhaps unfortunate that the two camps have not met and mingled more. However, at the same time, there are benefits in the ways they contrast with and complement one another. The special perspectives and analytical *armamenta* of two distinct academic disciplines now provision contemporary efforts to teach thinking. We exist in a time of fortunate confluence between the need as perceived by a concerned public and educational leaders, and new and powerful ideas about ways and means to improve and further education

emerging from the disciplines of psychology, philosophy, and, of course, education itself.

Do Not Schools and Good Teachers Already Develop Thinking?

Certainly, to some extent they do. Plentiful experimental evidence shows that formal schooling has a marked impact on the cognitive functioning of many students. They learn to think in ways characteristic of literate industrialized cultures, and since such cultures call for such thinking, this is important. (It is worth recalling that individuals growing up in other kinds of cultures may not benefit from the same patterns of thought, but this is not of direct concern to us.) There is no question that conventional schooling empowers many learners not only with a knowledge base but also with patterns of thinking appropriate to our culture.

Good teachers also do things that enhance their students' thinking. They may, for instance, ask more provocative questions, choose assignments better matched to the intellectual level of their students, and avoid dominating class discussion with their own opinions. These are only three among a host of factors that may foster the development of thinking abilities.

So what is all the fuss about? Partly, it is a search for replicability. To be sure, there are schools and teachers that plainly stimulate students' intellectual development, but just what is the nature of their flair and how can others get similar results? We all recognize that the conspicuous success stories are the exception, not the rule. Partly, it is a search for better ways. Some of the ideas about the nurture of thinking are novel enough so few if any schools or teachers would be likely to arrive at them spontaneously, particularly not in refined form.

The fact is that, whatever schools and teachers are already doing about thinking, we are dissatisfied. We look at the test results already mentioned and conclude that all too often students' responses fall far short of what we would like to see and what we think we *should* see in students. We look at the conduct of class-

rooms and find that, while teachers with a special flair or special training may foster their students' intellectual growth somewhat more effectively, most of the time in most of the classrooms much more could be done.

Two results might be mentioned in illustration. Abundant research shows that nearly all questions posed to students fall near the bottom of Bloom's well-known taxonomy and call for little more than the retrieval of content. In other words, most attention is given to "the facts." Students are seldom challenged to think. Second, research shows that in teaching we typically give students very little time to answer a question before providing an answer ourselves or turning to another student. The same research shows that giving students just a little more time to respond makes a marked difference in their thoughtfulness and in the whole intellectual atmosphere of the classroom.

In summary, it is fair to say that neither the results we are getting nor the teaching process lives up to what we desire. The best that can happen does not happen often enough. It is not that we have been doing so badly. Rather, we have become more ambitious. Recent attention to education has both brought to our attention shortfalls we had not recognized and alerted us to the prospects of much greater achievement. What seemed satisfactory decades ago no longer suits us. Now we want more.

Is There Any Evidence That People Can Learn to Think Better?

There is indeed. At this point, it is reasonable to conclude that in many circumstances and in a variety of ways thinking can be improved beyond what schooling typically achieves. This does not mean that the achievement can be taken for granted or easily won. Failures occur, the reasons for success are not always clear, and the criteria of success vary.

Nonetheless, the picture is basically positive. We believe that it will become more so as we learn more about managing efforts to develop students' thinking. Let us look at some details.

Perhaps the simplest question to ask concerns the immediate effects of interventions designed to improve thinking skills. Can they improve the sort of thinking they address, as measured immediately after instruction? Yes, they can. There are careful evaluations demonstrating improvement in such skills as informal reasoning, mathematical problem solving, creative thinking, and interpretive reading. There are also cases of improvement in academic performance across the board, including gains in IQ scores and school grades.

However, not all efforts to improve thinking have positive results. Sometimes one finds "no significant difference" between treatment groups and control groups on posttesting. Teaching thinking is a less reliable enterprise than teaching content in a subject area. For the latter, any reasonable teaching method and text will ensure that students learn a fair portion of the content, though perhaps not as much nor as deeply as one would like. Sometimes, however, seemingly reasonable efforts to teach thinking skills do not accomplish as much as we might hope. Often, the problem seems to result from insufficient time on task or inattention to the problems of internalization and transfer, which we will discuss later.

In any case, for several reasons we caution against discouragement based on such findings. Different efforts to teach thinking are often *very* different, so the failure of one approach leaves ample room for the success of others. Even two implementations of the same packaged program can exhibit a great contrast in thoroughness and sensitivity. Finally, the field is young. We are just learning how to implement approaches well, and in the years to come we will no doubt see more consistently positive results.

While many efforts to teach thinking are developed locally in individual school systems, implementations of published programs are also commonplace. Can one find out how effective these programs are? Sometimes, but not as often as one would like. A few of the published programs have indeed been formally

evaluated, but the entire field suffers from a problem of under-evaluation. Moreover, when advertising material claims that a program has tested out well, it is often important to find out more about the care exercised in the testing and the evaluation criteria. Are the kinds of reported improvements desirable in one's own context? For this reason and because, as noted above, sensible sounding interventions do not always work, it is very important for school systems implementing their own or others' approaches to do in-house evaluations with pretests and posttests. This need not be hard. It can serve as a guide to improving approaches or trying something else, and it provides valuable knowledge from which others can benefit.

Can efforts to develop thinking have lasting effects? Yes, indeed. There are some studies with evidence of effects lasting for a considerable period. Although there are also cases where gains have disappeared, we should not be dismayed. It is typical in schooling that gains do not last unless they are sustained by subsequent instruction. For the most part, unfortunately, we lack evidence about long-term effects. Very few formal evaluations have included retesting after a delay. We recommend that school systems do in-house delayed evaluation insofar as possible.

Does transfer occur? Can efforts to develop thinking impact on students' thinking in and out of school—beyond an intervention's most immediate concerns? Yes, again. There are several documented cases of transfer. Transfer does not happen with the regularity or strength one would like (see the discussion of transfer in chapter 7. Also, the record is sketchy: most evaluations have not included measures of transfer. Transfer, however, has become an area of special interest , and we forecast considerable progress in both attaining and measuring transfer.

Is teaching thinking for everyone? Does this include the gifted *and* the poor students? Emphatically yes—for everyone,

although not necessarily with the same intervention. The evaluations of some interventions show that the thinking and learning of poor to medium students can be improved across the board. Also, the performance of able students can be improved in particular subject areas. We know of no adequate evaluations of the few approaches that attempt to improve able students' across-the-board performance, but this probably can be done.

It is gratifying to see evidence that thinking can be taught. But how should one feel about the sparse evidence overall and the fact that gains—lasting gains—and transfer may not occur, even for approaches that seem sound on the surface? We suggest a need to be philosophical about this. The field is young and full of innovation. It is hardly surprising to find that things do not always work, and that we do not have as much information as we would like. All the more importance is attached, then, to people trying new things so that we learn more about how we are doing and how to do better. Already we know much more about teaching thinking than a decade ago. Since lasting effects and transfer can be obtained, it is highly likely that we will learn how to achieve such results with reliability. Already we know some things about the conditions likely to foster retention and transfer. It is important that those who see as urgent the need to teach thinking—and the need to discover how to do it— now become more actively involved in the field.

Are Not Most Learners Functioning at Their IQ Or Developmental Ceilings?

Many people ask this question from concern that matters of IQ or Piagetian stages lock learners into a certain level of performance. They feel they cannot help students to think better because the students are already functioning at their natural ceilings. Fortunately, research shows neither factor imposes rigid limits.

Table 1.1. Some Points about IQ

IQ scores are important, but...	IQ measures only a part of what we mean by intelligence.
IQ predicts academic achievement, but...	IQ often does not predict professional success.
IQ scores can be increased, but...	IQ scores that have been increased fade with time.

Consider some points about IQ. First of all, IQ scores only measure a part of what we ordinarily mean by intelligence. IQ predicts academic achievement reasonably well, but it often does not predict professional success in a field after schooling. The latter appears to depend on other aspects of intelligence. Second, certain teaching experiments have increased IQ scores very substantially. To date, those effects have faded in a couple of years, but as we emphasized earlier, this is commonplace in learning when nothing is done to sustain gains. Third, as we mentioned above, a number of studies have demonstrated that students' thinking *can* be improved, IQ notwithstanding. Even proponents of the centrality of IQ to human intellectual ability acknowledge that particular kinds of thinking can be enhanced, much as any particular skill allows some development. In general, while IQ certainly has something to do with certain kinds of intellectual potential, it is plain that most students are *not* functioning at their "IQ ceilings," if indeed this concept even makes sense. There is plenty of teaching to do before we start to encounter ceiling effects.

Another source of concern about what students might be able to achieve is the developmental theories of Piaget. Although we cannot review Piaget's perspective here, perhaps it is enough to

say that Piaget proposed a model of human development in which intellectual competence depends on attaining broad pervasive stages of development. The higher the stage reached, the more sophisticated the thinking of the person. Certain points about Piaget's view limit what one might hope to accomplish in enhancing students' thinking. For instance, according to Piaget, before a person is ready for a certain stage, instruction does not help much. This challenges some of our aspirations. For instance, the stage of formal operations, that typically arrives during adolescence or later, involves formal logical understanding and other patterns of thought that many would like to teach earlier.

However, Piaget's perspective does not really pose these apparent difficulties. Extensive research over the last decade and a half has disclosed that in key respects, the Piagetian perspective cannot be completely substantiated. First of all, intellectual development is not as much "of a piece" as Piaget originally proposed. People can advance far in some respects while lagging behind in others, so by choosing areas of special concern and teaching to them one might help students to attain intellectual skills crucial to particular enterprises. Second, the sweeping limits proposed by Piaget, such as youngsters being unable to reason formally in any respect until their late teens, have been disconfirmed. In many ways, five- and six-year olds exhibit patterns of logic. Consequently, one need not hold back on all instruction concerning, for instance, the structure of scientific thinking until late adolescence. Finally, even if Piaget turns out to have been right after all about broad, general stages, Piaget himself always emphasized that different individuals may develop at very different rates—another reason to be cautious about approaches that make strong assumptions about what children can or cannot do at various ages.

One important limit has emerged, however. Difficulties that Piaget identified with stages in the development of broad cognitive structures seem to have a somewhat different cause. They are the result of the gradual development of human short-term memory capacity. Short-term memory increases as people grow. Young-

sters have trouble learning certain kinds of concepts (logical, scientific, etc.) because they do not have enough short-term memory capacity to represent to themselves and manipulate the complex concepts. Note that this short-term memory bottleneck does not exclude whole classes of thinking, like scientific or logical thinking. Rather, it constitutes a limit on complexity. The moral becomes: seek to develop whatever *kind* of thinking you want in youngsters, but beware of *complexity* in the early school years, and, indeed, in general.

Failure to observe this distinction between kind and complexity can lead to inherently limited instructional design. Sometimes educators feel students cannot begin to learn certain kinds of thinking until a particular age and therefore omit them. We know of at least one program to promote scientific thinking that defers all attention to substantive issues of hypothesis and verification until the later school years on the grounds that youngsters cannot understand them at all until later. Not only is such a view mistaken, but incarnated in programs of instruction, it becomes self-fulfilling prophecy: if students receive no help in understanding such ideas until late in their schooling, certainly they will not understand them beforehand.

In summary, then, neither IQ nor Piaget's developmental perspective imposes strong limits on the opportunity to develop students' thinking. This is true in both cases for the same two broad reasons. First, neither factor proves to be as encompassing an account of human intellect as one might suppose. Second, whatever limits these factors do create, students are not typically operating *at* those limits but *below* them.

To sum up, in this chapter we have looked at a number of ways in which the teaching of thinking might prove a futile Quixotic quest. Approaches to the development of students' thinking might reveal a disastrously fuzzy or narrowly exotic concept of thinking and how to improve it. Good schools and teachers might already nourish students' thinking as much as possible. Considerations of IQ and Piagetian development might

put a low ceiling on what one could hope for, and so on. But not one of these concerns turn out to be valid. The possibility of teaching thinking and its promise are real. To realize that possibility and harvest that promise, however, we need to take a sharper look at the nature of thinking and its improvement.

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CHAPTER TWO

THINKING AND ITS IMPROVEMENT

In chapter 1, we emphasized that the movement to develop students' thinking entails no exotic or narrow concept of thinking or its improvement. Better thinking means what you might think—better problem solving, decision making, reasoning, and so on. However, in a way the familiarity of the sorts of thinking concerned is deceptive. We may know our own thoughts, but we do not know our own thinking so well. When thinking improves, exactly what about it develops? For instance, is better thinking the consequence of a kind of neurological "muscle building" achieved through exercise? Also, just what sorts of thinking need to be developed? Above, we mentioned problem solving, decision making, and reasoning, but under broad interpretations of each, are they not virtually the same thing?

Questions such as these warn us that there is more mapping of the terrain to do before applications in the classroom can be considered. In this chapter and the next, we lay out several ways in which instruction might improve thinking and characterize major kinds of thinking that schooling might address.

What Is a Thinking Skill?

Before we start in earnest, a matter of terminology needs attention. People speak of developing students' "thinking skills." But what is a thinking skill? Roughly speaking, *a thinking skill is a competency that contributes to some kind of thinking*. Thus one can speak of thinking skills involved in critical thinking, creative thinking, decision making, and so on. To emphasize that these skills contribute to more holistic thinking endeavors, one might even speak of "subskills." For instance, some subskills (or, for short, skills) of critical thinking might include generating rea-

sons, assessing reasons, forecasting consequences, and so on. The broad agenda in teaching thinking skills is to identify skills (subskills) relevant to the desired kinds of thinking and improve students' thinking by some mix of teaching them the relevant skills and setting up situations in which students improve their own skills.

Unfortunately, the term "skill" can easily be misleading here. First of all, talk of thinking skills suggests that good thinking is only a technical matter—acquire those skills and you will do well. In fact, good thinking involves commitment, attentiveness, and many other factors besides skill in a narrow sense. We will discuss some of these other factors in the next section.

The term "thinking skills" is deceptive in another way also. It suggests that there are components of thinking that you can "practice," much as you would "practice" smoothness of scales in piano playing or steadiness of stance in tightrope walking. However, this is only a partial truth. There is reason to believe that skills of thinking are enhanced not so much by practice alone as by strategic reorganization. For instance, if you want to get better at generating creative ideas, you are likely to find that *mere* practice does not help that much, but systematic strategies for conceiving ideas, with practice, help quite a lot. This, too, will be a point developed in later sections.

Just to make matters even more complicated, many people now working in the field of teaching thinking understand all this. They know that good thinking involves more than skill in a narrow sense and that skills come from strategic reorganization, not just from practice. However, they use the term "thinking skills" elliptically, as a short way of saying "thinking skills, attitudes, and so on, with appropriate strategies." So when a person says "thinking skills," you do not really know whether the person has a narrow or broad conception; you have to find out.

It's regrettable that so much confusion attaches to the term "thinking skill," but that is the present reality. Within these pages, we adopt a consistent convention. *We use thinking skills in a*

noneliptical sense signifying subskills, that is, component competencies of different kinds of thinking. We do not treat as a single thinking skill a major category of thinking like critical thinking, creative thinking, decision making, or problem solving; rather, we say that such kinds of thinking depend on a variety of subskills. We always see skills as only one factor in good thinking. We always see such skills as based on strategic reorganization, not just on practice.

When Thinking Gets Better, What Is It That Improves?

The easiest introduction to this question comes by way of an example. Consider, for instance, a kind of thinking widely recognized as important both in everyday and academic contexts: decision making. Broadly speaking, the sorts of considerations involved in decision making seem clear enough. You need to explore the options at hand: typically you recognize a decision situation because you see at least two options, but perhaps there are more worth considering. Then you need to consider the reasons in favor of or against the various options—what are the consequences, what are the costs, and so on? Then you have to sort out the various factors and reach a resolution. Or, sometimes, if the decision can be deferred, it's better to seek more information.

Now suppose some person—let's call her Margaret—reads a "how to do it" book, takes a course, or receives some good advice over a period of time from a friend, and her decision making gets better. What *about* it might improve? We will discuss "what improves" under six headings: awareness, effort, attitude, organization, subskills, and smoothness. Let us see what each of these might mean.

Awareness. For one thing, Margaret becomes more aware of decision making as a process. She notices herself making decisions. She also catches herself making decisions by default, when she might have considered them more thoughtfully. As she goes about working through decisions, she becomes conscious of quirks in her behavior—how, for example, she often wants to get

the decision done with and so feels an impulse to settle it any old way. This awareness helps Margaret to tinker with her decision-making process and try to improve it.

Effort. As Margaret becomes aware of her decision-making processes, she also invests more effort in them. The casual impulse pursued in five seconds now often seems worth one minute to make a quick pro-con list in her head. More major decisions lead her to pencil and paper, so that she can carefully map out the possibilities and consequences. Margaret is aware that she might overdo it and tries not to make a big deal out of minor decisions. But, as a trend, her decision making receives more careful and extended attention.

Attitude. Coupled with these changes in awareness and effort comes a change in attitude. Decision making now seems to Margaret to be a more important undertaking than it did before. She finds herself curious about how she conducts her decision making, ready to explore alternative approaches of making decisions, and interested in discussing important decisions with friends. She feels a greater sense of responsibility for the decisions she makes in behalf of herself and in behalf of others.

Organization. Margaret finds that major improvements in her decision making follow from reorganizations of the process of decision making. She learns or invents strategies that lead her to organize the process in more elaborate and sounder ways. For instance, instead of just dealing with the obvious options that present themselves in a decision making situation, Margaret tells herself to try to think of new options: Among them may be the one most worth choosing. Instead of just weighing intuitively which option looks best, Margaret often stops to jot a list of pros and cons on paper; she finds this makes it easier to sort out which course of action is most likely to work well.

Subskills. As Margaret reorganizes her overall decision-making process, she discovers a number of subskills that go into the process. She notes, for instance, that she has to think of reasons pro and con and that she needs systematic ways of

balancing important and less important pros and cons against one another. Margaret learns better ways of organizing these subskills. For instance, she acquires tricks for thinking of more important pros and cons when she seems to deplete her list—setting herself a quota of five more, looking at the matter from someone else's perspective, trying to think of long-range consequences.

Smoothness. As Margaret explores these new directions in her decision making, at first it all seems somewhat awkward, like new shoes. However, Margaret soon becomes used to these novel patterns of thinking, and indeed accustomed to reflecting on her thinking at odd moments in search of yet better ways to make decisions. Now, when she faces a decision, her more elaborate approach runs off smoothly and comfortably. In psychological terms, many aspects of her new decision-making process have become automatized and habitual, even though she remains reflective about her thinking.

Of course, other elements besides these six contribute to the quality of Margaret's decision making. For one, there is what she knows about the matter at hand. Margaret may know a lot about rock music, so it is easy for her to decide whether to attend a particular rock concert; she may not know much about classical music, although she enjoys it, so a reliable decision about an upcoming classical piano concert comes harder. She can improve her decision making in an area simply by learning more about the area. However, this content knowledge is not listed as one of our dimensions of improvement because it is not a *general* aspect of decision making; it is tied to the particular topic of decision.

Yet another factor contributing to good decision making is general mental ability as measured, for instance, by IQ. In the previous chapter, we already offered a number of cautions about the significance of IQ. Yet it is unlikely that Margaret's IQ has improved just because she has become more aware of decision making, invests more effort in it, and so on. One might say that, as more content knowledge is too specific, an increase in IQ is too general to associate with an improvement in decision making. In

summary, the six factors of awareness, effort, attitude, organization, subskills, and smoothness are offered as a practical way of sorting out what it might mean for Margaret's decision making *per se* to improve.

Table 2.1. What Improves When Thinking Gets Better

1. Awareness of one's own thinking
2. Investment of effort in one's thinking
3. Attitude towards thinking processes
4. Organization of thinking processes
5. Development of subskills
6. Smoothness in the thinking process

Applications to Other Kinds of Thinking

Memorization. These same six factors serve just as well in describing the basis of improvement in other kinds of thinking. Consider, for example, a kind of thinking we usually take to be quite routine: memorizing. What might change to improve your memory? Well, if you become more aware of when and how you go about memorizing, that would give you more leverage on the process. If you invest more effort in memorizing when you need to memorize, you would be likely to retain information better. Perhaps you have disdained many learning situations as requiring "mere memory"; but an attitude change to viewing these as challenging situations might help you take them more seriously and

cope with them more effectively. You may notice that you already have two or three strategies for organizing your memorizing activities, such as testing yourself, using mental imagery, or categorizing what you're trying to learn. You can acquire more of these ways of organizing your efforts to memorize, and they will make your memory more effective. Any such approach involves a variety of subskills—how to think up mental images that help to make information stick, what kinds of categories work best—and as you discover more about how to handle the subskills that go with a particular strategy, the strategy works better. Finally, if you engage more seriously and strategically in memorizing activities, you will find that the new patterns of behavior soon become smoother.

Creative Thinking. Relevant to less prestigious kinds of thinking like memorizing, the six factors are just as germane to such revered enterprises as creative thinking. Greater awareness of both opportunities to create and your own creative processes may help you to be a better and more productive "inventor." (Contrary to some popular thought, there is really no reason to believe that, in general, self-awareness inhibits creativity, although self-conscious *anxiety* about one's creative potentials may be inhibiting.) If you invest more effort in creative pursuits, you are likely to get more creative results.

Regarding attitude, many people classify themselves as uncreative, which surely makes it so—a matter of self-fulfilling prophecy. If your attitude changes to recognize the creative potential in yourself, you are likely to become more creative in consequence. As to organization, you can reorganize your patterns of thinking to encourage creative results; for instance, by brainstorming more, seeking original solutions, tackling problems that demand inventiveness for their solution, and so on. Creativity involves a variety of subskills—for instance, how to get ideas through random association, generalizing the problem, making the problem more concrete, and so on. Finally, as you engage in all this, creative activities will become smoother.

In summary, the sextet of awareness, effort, attitude, organization, subskills, and smoothness provide a useful way of naming several dimensions of potential improvement in thinking. The six are particularly important to keep in mind because they are somewhat independent of one another. For example, it is perfectly possible to learn strategies that help one to reorganize one's decision making and yet experience no change of attitude or awareness. It is perfectly possible to become more aware and develop better attitudes toward decision making and yet not quite know how to go about reorganizing one's ways of decision making to do a better job. So, although related, the six are separate enough to warrant individual attention and to warn that efforts to develop students' thinking can all too easily be one dimensional.

Indeed, this point creates an opportune moment to shift to considering the instructional implications of our discussion of "what improves." Around the theme of "what improves" cluster a number of hazards that get in the way of effective education for thinking, and a number of ways of helping ourselves around those hazards. We turn to several cases in point.

Helps and Hazards in Improving Thinking

>> Breadth of approach

Hazard: One-dimensional approaches. There is a tendency to consider good thinking as "one thing": a matter of strategies, attitudes, or "mental muscles" that get stronger with exercise. Accordingly, many efforts to develop students' thinking are one-dimensional, working on only a single element of the six outlined above, or at best two-dimensional. For example, it is not unusual to find practice-intensive approaches that simply offer students plenty of exercise with a certain kind of problem solving. The practice tends to build smoothness in students' use of whatever strategies they already have and may encourage more effort. But research shows that straight practice does not work as well for thinking as it does for, say, skating or hitting a baseball. Often, mere practice has *no effect at all*. Why? The evidence

suggests that students really need to reorganize their thinking with new strategies and then practice these.

For another example, one often finds a pure strategy approach that simply tries to reorganize the thinking activity in question but does not provide much practice. Many strategies for decision making and other kinds of thinking are rather simple sounding, so educators sometimes feel that students do not need much practice: students simply have to be told about the strategies and the job is done. However, unless students have some experience in using the strategies, they are not going to stick, much less will students become fluent. A pure strategy approach also leaves awareness and attitudes wanting for attention. Without such attention, one is teaching mere technique with no sense of occasion. Students may learn the technique but are not likely to use it autonomously.

For a third example, often one encounters subskills approaches that seek to build up a particular kind of thinking by working from a list of relevant subskills for, say, decision making, and teaching them to students. Unfortunately, commonly such approaches simply offer practice for the subskills, not better ways to organize them. Also, such approaches often use a limited set of subskills that only partially cover the overall kind of thinking in question. In addition, often these same approaches may neglect the overall organization of the kind of thinking under consideration: how does one put together the various subskills in a coherent approach to decision-making or other kind of thinking? One can't see the forest because of all the trees. Finally, matters of attitude are likely to suffer under a rigorous regimen of detached skill after detached skill.

A fourth hazard resides in a pure awareness and attitude approach, where the classroom atmosphere reflects the valuing of a particular kind of thinking and encourages attention to it. The problem is that organization is crucial. Many students in a "thoughtful classroom" appear not to catch on to the ways they can reorganize their thinking to get better results. Without direct

and explicit attention to organization, the most nourishing thinking atmosphere may fail to have the desired effect.

Help: A well-rounded approach. The help to counter the foregoing hazards is straightforward enough: a well-rounded approach to the development of students' thinking that pays heed to the multidimensional character of what improves when thinking improves. Such an approach will:

(1) build awareness of the kind of thinking in question;

(2) promote greater investment of effort toward this kind of thinking;

(3) promote positive attitudes toward this kind of thinking;

(4) explicitly provide better ways to organize a kind of thinking or perhaps lead students to create such explicit ways for themselves;

(5) introduce students to relevant subskills and provide or elicit ways of handling them better; and

(6) find frequent occasions for practicing the kind of thinking.

This does not mean that all six elements must receive attention at every moment or that each should consume equal time with the others, but that they should all be part of the overall agenda.

>> The relationship between content and thinking

Hazard: Content first, thinking later. The point is often and rightly made that thinking has to be thinking about something. Sometimes this is taken to mean that students are not ready to think about a field until they have acquired a considerable base of knowledge and fundamental techniques. For instance, some feel that students cannot write essays until they have a thorough understanding of punctuation and paragraph structure, or that they cannot do even elementary mathematical thinking until they have mastered the basic operations of arithmetic. Research shows that

this is simply false. There are many opportunities to engage youngsters with limited writing skills in meaningful writing tasks, or with limited mastery of the operations of arithmetic in thoughtful explorations of matters mathematical. Indeed, we agree with the many who argue that postponing such activities contributes to lack of student interest, because the subject matter in question comes to seem a mere matter of rote knowledge and skills.

Hazard: Thinking first, content later. This hazard is complementary to the above. Sometimes it's imagined that improvement in various kinds of thinking will set the stage for easy mastery of content. We can make students good mathematical problem solvers if only we teach them, in advance, some sound general principles of mathematical problem solving. Then, when we feed them the details of some new mathematical content, they will be equipped to understand those details readily and apply them fluently in solving problems. Unfortunately, this works no better than the "content first, thinking later" approach. Any new body of content requires time and care to assimilate. To be sure, a better thinking process will help in mastering new content, but it will not make the matter routine. One reason is that general ways of organizing one's thinking need to be adapted somewhat to new content; another is that new content usually brings with it the need for particular ways of organizing one's thinking not yet in the learner's repertoire.

Help: Thinking and content learned together. When thinking and content are learned together, the thinking illuminates the content and vice versa. "Together" need not mean "in the very same course," although many of the most interesting current efforts to develop students' thinking do integrate the teaching of thinking with the teaching of the subject matters. But at least it means that students are learning, in one place or another, ways of thinking appropriate to the content they are acquiring. For instance, they are learning ways of problem solving relevant to the level of math they are studying, communication skills relevant to

their level of writing mastery, and strategies of critical thinking relevant to their work in history and social studies.

>> Learning about and learning to do

Hazard: Only learning about. Thinking is a performance—something to be done. Sometimes approaches to developing students' thinking treat thinking as a subject matter, something to be learned about. For instance, in a course on critical thinking, students might learn about the structure of arguments, the fallacies commonly found in arguments, and the ways arguments contrast in different domains such as science, mathematics, and law. All of this is interesting and important: it *may* improve the critical thinking of some students. Unfortunately, for most students it will have no impact at all on their actual critical thinking. Students have learned *about* critical thinking but have made no effort to put precepts into practice.Why should they since they have not been asked to? That has not been the instructional agenda.

Hazard: Only learning to do. The natural remedy to learning about seems to be setting it aside and focusing only on learning to do. For example, one might attempt this simply by giving extended practice, or simply by offering recipe-like strategies and encouraging students to use them. However, these are just the sorts of approaches characterized earlier as one-dimensional: they address only a couple of the six aspects of improving thinking.

Help: Learning about plus learning to do. A sound program aimed at developing students' thinking gives them the opportunity both to learn about thinking and to do it. "Learning about" equips them to be aware of and reflective about their thinking processes, to ponder their attitudes and to edit their strategies. "Learning to do" equips them with ways of organizing their thinking, provides practice in those ways, and encourages effort invested in the kind of thinking in question.

Table 2.2. Hazards and Helps in Improving Thinking

A. Breadth of Approach
   1. Hazard: One-dimensional approaches
      a. Straight practice
      b. Pure strategy without practice
      c. Detached skill approach
      d. Pure awareness and attitude approach
   2. Help: A well-rounded approach

B. The Relationship Between Content and Thinking
   1. Hazards
      a. Emphasis on learning content first
      b. Emphasis on mastering thinking first
   2. Help: Thinking and content learned together

C. Learning About and Learning To Do
   1. Hazards
      a. Learning only *about* thinking
      b. Focusing only on *doing* thinking
   2. Help: Learning *about* and *to do* together

D. Student Ownership
   1. Hazard: Teacher control
   2. Help: Fostering ownership

E. Transfer of Thinking
   1. Hazard: Context-bound learning
   2. Help: Attention to transfer

>> Student ownership

Hazard: Teacher control. Often thinking strategies are played out in the classroom in ways that leave the teacher in control of the thinking processes. For example, whole group discussions are a popular and useful way to apply a thinking strategy to content. A teacher might lead a history class through the steps of a decision-making strategy applied to Truman's decision to drop the A-bomb on Japan. Such activities are certainly worthwhile as part of a program to develop students' thinking. However, if this is the only kind of activity, there is a problem of student autonomy. The teacher is always the navigator, who steers the path of the thinking. To be sure, the students think; they generate options, ponder alternatives, and so on. But thinking is not enough. To learn to think better, students must develop the organization and awareness to guide their thinking, instead of just learning to respond to the teacher's lead.

Help: Fostering ownership. Solving the hazard of teacher control certainly does not require that students be "out of control," nor does it entail abandoning useful classroom techniques like whole group discussion. What it does imply is that, some of the time, students guide themselves fairly autonomously through thinking activities. For example, a teacher might start introducing a decision-making strategy just as described above, but reduce control on later applications. One way or another students need to have activities where each works alone. A good way to build toward solo activities is through small group activities, where pairs or trios of students lead themselves through a thinking activity. Such group work makes a useful bridge between whole-class activities where the teacher is in charge, and solo activities where students are on their own. Indeed, we consider it likely that small group activities may be the single most useful mode of interaction, the one that should occupy the highest percentage of activity time in the classroom as students learn to think.

>> Transfer of thinking

Hazard: Context-bound learning. It's often presumed that better thinking learned in one context will naturally and spontaneously spread to others. Research shows that this often is not the case. One can learn problem-solving strategies in math that fail to carry over to physics, much less to English. One can learn ways of critical thinking in social studies that never surface in history. Sometimes the reason is that kinds of thinking acquired in one context are special to that context and have no application elsewhere. For instance, math includes problem solving strategies like "mathematical induction" or "integration by parts" that have no relevance outside of math. But a large part of the problem is quite different: many patterns of thinking learned in one context, although in principle general, become associated with the context. It never occurs to the student to apply them elsewhere.

Help: Attention to transfer. Just because transfer typically does not occur spontaneously does not mean transfer of learning from one to another context cannot be obtained. One simply has to work for it. There are a number of specific things that can be done to encourage transfer. For one, students should be made aware of the problem. For another, instruction in a particular kind of thinking should involve a variety of examples, including a few that reach beyond the immediate boundaries. For example, if a problem-solving strategy is being taught in math class, it's desirable for the teacher to steal a little time now and then from mathematics to explore how this strategy might be applied in physics or English. For a third, students should be encouraged to be aware of their own thinking processes whenever they face a problem situation. They should ask themselves, "How am I going to approach this? Do I know anything I've learned elsewhere that could help?" And so on. Research suggests that such deliberate awareness of one's thinking promotes transfer.

In summary, the improvement of thinking is not a straightforward "practice-makes-perfect" enterprise. It is a more subtle and strategic endeavor in which practice is only one and not even

the dominant element. Instruction needs to help students to develop awareness of their own thinking, conducive attitudes, and empowering strategies. Instruction should avoid simplistic approaches such as segregating thinking from content or just teaching students about thinking without engaging them in thinking. Educators must bear in mind the importance of student ownership and of teaching for transfer. While these complexities make the cultivation of student's thinking more challenging, they also map realistically what needs to be done and help us to do it.

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CHAPTER THREE
KINDS OF THINKING

"What about thinking improves?" is one question, but "What kinds of thinking should we try to improve?" is another that is equally pressing. An educator interested in improving students' thinking and surveying the current array of programs and approaches can hardly avoid experiencing confusion. Thinking comes in so many brands under so many labels. Some perspectives appear utterly different, some seem virtually identical in all but name, and some fall in between. How to make sense of this diversity and sort out the real options becomes a challenge.

Our approach in this document is a practical one. We do not purport to offer a definitive taxonomy of different kinds of thinking. Indeed, we suspect that there is no ideal taxonomy because the complex landscape of thinking can be partitioned in many different equally reasonable ways. Rather, we base our discussion on several categories of thinking that in fact are much used in everyday speech and in the current thinking skills movement. In the section below, three broad and prominent categories are reviewed—critical thinking, creative thinking, and learning. In the next, three somewhat more specialized categories are examined—decision making, everyday problem solving, and problem solving in math and science. Following that is a discussion of metacognition, a category so important and crosscutting that it deserves a section all its own.

These categories overlap in various ways, a point to be explored as it comes up. But they are somewhat distinctive as well. Moreover, taken together they are fairly comprehensive: a program that paid attention to all of these would be potent indeed in developing students' thinking abilities.

To organize better the exploration of the categories discussed in this chapter, we will treat each under four headings—*target*, *challenges*, *helpful strategies and attitudes*, and *subskills*.

- *Target* refers to the kind of problem that the category of thinking addresses: with what is the type of thinking, in question, meant to help us ?
- *Challenges* points to characteristic difficulties: how does the kind of thinking typically fall short; what are the hazards?
- *Helpful strategies and attitudes* includes a brief summary of some strategies and attitudes that should promote better thinking of the kind in question.
- *Subskills* lists a sample of component skills that need to be developed in service of the kind of thinking in question. These subskills, of course, also should be approached strategically; they should not just be practiced.

The following discussion is not intended to be a recipe for classroom practice. Not nearly enough detail is offered about the challenges a thinker faces or the strategies and attitudes that might help. It's hoped, however, that the information here will offer a bird's eye view of several important kinds of thinking and assist practitioners in selecting what kinds of thinking deserve attention in their own particular contexts.

Some Broad Categories of Thinking

>> *Critical thinking*

Target. We interpret critical thinking to concern the critical examination and evaluation—actual and potential—of beliefs and courses of action. Columbus discovered America in 1492, it's said. How do we know? What are the grounds for believing that? If historical documents are involved, what evidence is there that they are sound? Or consider a more contemporary matter: ought the presidency of the United States to be limited to two terms?

What are the arguments for and against? Are there moral issues involved, and what are they? As these examples illustrate, in critical thinking we

- aim at critical judgment about what to accept as reasonable and/or to do;
- use standards that themselves are the results of critical reflection in making these judgments;
- employ various organized strategies of reasoning and arguments in determining and applying these standards; and
- seek and gather reliable information to use as evidence or reasons in supporting these judgments.

The term "critical thinking" is sometimes interpreted in a much broader sense than this. Critical thinking has become a banner word for many educators: "We need to teach critical thinking in the schools." Given its popularity, many educators and scholars prefer to include in critical thinking virtually all good thinking, encompassing, for example, the next two categories discussed here. In contrast, other educators and scholars subscribe to the narrower sense employed here. They feel that it affords more focus and that we need a vocabulary distinguishing, albeit roughly, different sorts of thinking rather than lumping them together. There is, of course, no ideal resolution since genuine trade-offs exist between the two policies for using the term "critical thinking." We simply want to alert readers to the different uses and underscore the convention adopted by the authors for this book.

Challenges. In many cases of belief and judgment, the principle challenges are ones of elaboration and evenhandedness. People typically examine stances with preconceptions about the resolution and so tend not to produce very elaborate rationales, even on their preferred side of the case. There is a very strong inclination to ignore almost entirely the other side of the case. Even more deeply-rooted challenges emerge when people confront issues that involve conflicts of basic religious, political, cultural, or

other tenets. Then it can easily happen that divergent viewpoints cannot even be argued in the same terminology, against the same foundation of agreed-upon assumptions.

Strategies and attitudes. Some simple strategies for critical thinking address the problems of under-elaborate and one-sided thinking just mentioned: one can encourage students to search more thoroughly on all sides of a case for reasons. One can urge students to critique the reasons they generate and weight their relative importance. Also, many attitudes are relevant to critical thinking. Examples of these would be fair mindedness, concern for objectivity and evidence, and openness to argument.

When the circumstances involve fundamental conflicts of premises, the enterprise of critical thinking becomes even more precarious and requires more sophisticated strategies. For instance, if the individuals engaged in discussion are willing, it can be powerful to pull back from the particular issues and try to unpack each party's underlying assumptions. This strategy benefits from and fosters an attitude of detachment, even about one's own world view. The consequence of such activities often will not be resolution of the original issue, but will be more understanding and respect for alternative points of view. This in itself is an important gain; we should not conceive critical thinking solely as a technique for settling the truth and justice of things, but rather as an enterprise of inquiry and understanding.

Subskills. All these general strategies for approaching critical thinking are served by various subskills. For instance, in considering a case, one can find a few reasons on both sides simply by trying, but if one wants a lot more, one may have to develop the subskill of reason generating. As we have emphasized before, growth in such skills should be seen mostly as a matter of better organization rather than the exercising of some mental muscle. Accordingly, the learner needs strategies for the subskill of reason generating. Such strategies might include the use of mental imagery to remind oneself of details of the situation, and the use of key questions that lead to different sorts of reasons: What are the

consequences? What are the different viewpoints? What are the needs? What are the side-effects? And so on.

Many approaches to developing critical thinking emphasize subskills of dealing with different kinds of evidence. For example, consider the subskill of appraising the report of a witness to an event. Again, a strategic approach is taken. Among the questions students are usually encouraged to ask themselves are: Were the conditions of observation good? Is there any reason to expect bias in the witness? How recently did the witness observe the event in question?

Subskills related to the relevance and strength of evidence in such inferences as causal explanation, prediction, and generalization are also important in critical thinking. Similarly, skills at deductive reasoning are also emphasized, especially in critical thinking courses.

>> *Creative thinking*

Target. Creative thinking implies thinking that is both effective and original. Thinking that is merely original, without yielding something in some sense effective, is simply a fun, but nonproductive exercise. On the other hand, thinking that yields effective results but without originality is good to have but does not count as creative thinking. Prototypically, creative thinking involves the production of some kind of complex product—a painting, poem, scientific theory, proof of a theorem, new kind of business, innovative ad, original garden, fresh style of party, novel joke.

Challenges. The classic challenge of creative thinking is "breaking set" and seeing a situation in a new way. Thinking tends to be dominated by old patterns and categories, and it is easy to overlook novel but effective approaches. Another challenge, more recently recognized, is "problem finding." Creative thinking is not just a matter of novel resolutions of old problems and questions, but finding and formulating new problems and questions altogether. Brainstorming is a common technique used

here. Of course, creative thinking involves critical thinking, too (a point to be discussed more later), and so another challenge of creative thinking is striking a fruitful balance between its creative and critical side. Occasionally one finds individuals who are full of novel and interesting ideas but have little sense of which are most productive and little ability to develop them into mature form. On the other hand, one sometimes finds individuals who are so critical about the novel ideas they conceive that they never feel satisfied enough to develop their ideas.

Strategies. Typical strategies of creative thinking include freewheeling production of ideas; searching for the boundaries of one's thinking—the underlying assumptions, habitual tracks, cultural barriers—so that one can reach beyond them; and exploring different ways to formulate or represent a situation. Attitudes to foster include a sense of freedom and exploration, zest for the novel and provocative, and tolerance of confusion and ambiguity.

Subskills. The most often identified subskill for creative thinking is flexible and fluent thinking, that is, the skill of thinking of many varied ideas. Some approaches to developing creative thinking emphasize improving this skill through extensive practice. But a "flexible and fluent thinking" approach to building creative thinking is quite narrow. How about the problem of meaning? How about fashioning initial ideas into complex products? Also, flexible and fluent thinking is best developed through approaches that couple practice with reorganization of one's thinking through strategies provided by the teacher or developed by the students. For instance, one such strategy might be called "track switching": monitor the ideas you are listing in response to a problem and deliberately seek a new kind of idea after you have listed three or four along the same lines. Another important strategy is to defer criticism: often critically reviewing each idea as it comes up seems to interfere with a wide-ranging exploration of possibilities. Of course, creative thinking involves many other subskills as well, e.g., how to find worthwhile problems and op-

portunities, evaluate approaches, improve candidate solutions, assess results, etc.

>> *Learning for understanding and the active use of knowledge*

Target. This is the only one among our categories with a long and unfamiliar name, and that in itself speaks to the all too-frequent neglect of fundamental problems of learning. By definition, learning involves memory, and as we emphasized earlier, memory certainly is one of those aspects of thinking that can and should be improved. But of course mere memory is not enough. We want learning with understanding. This objective has transparent relevance to much of schooling, where students often learn rote answers and rote rituals, such as the long division algorithm, without really grasping the substance or import of what they have memorized. Moreover, we want the active use of what is learned. Research shows that students master considerable knowledge and skills that they rarely think to apply except on exams. Such learning is "inert."

Challenges. Typical school settings in many ways work against learning for understanding and learning for active use of knowledge and skills. For one point, there are often coping-with-school strategies that students can follow that do not require understanding. For instance, students can memorize the dates of history or the formulas in physics and do adequately on the exams. For another point, little in the typical curriculum encourages the active use of knowledge in realistic contexts of thinking. Knowledge is exercised mostly through multiple choice, fill in the blank, and textbookish problems that constitute a culture in themselves. Students learn this culture and often are even resentful when innovative teachers throw in an open-ended question that breaks the pattern of the school culture.

Strategies and attitudes. Any number of learning strategies that can be pursued both by teachers and students address the challenges identified here. One is to eliminate mechanical problems so that students *must* understand the concepts they are deal-

ing with in order to do the work. Another is to emphasize models, images, and metaphors in learning a new concept, and to connect a new concept to the purposes it serves and the arguments that justify it. A third is to engage in "problem-based learning," where students must seek information in their texts and puzzle out subproblems—all in the context of some larger problem or project. Research shows that learning acquired in this way is much more active. Integration of critical and creative thinking, or of the more specific kinds of thinking discussed next, into subject matter instruction should tend to produce a more active base of knowledge. In a later chapter, we will discuss in more depth how to infuse thinking into subject matter instruction. As to attitudes, a valuing of understanding, a tone of inquiry, and a press to make knowledge and skills work for you in diverse ways are important dimensions of learning for understanding and the active use of knowledge.

Subskills. A number of subskills foster learning for understanding and the active use of knowledge. For example, systematic reading methods that involve previewing the text, formulating questions, reading for the answers, and then reviewing at the end by means of the questions are helpful. Memory skills that highlight making material meaningful and personalizing it are relevant. For instance, one can try systematically to associate new material with things one already knows, including personal experiences. Translating new material into alternative representations is a skill that can powerfully aid understanding—illustrating, making graphs, composing mental movies, and so on. These points merely sample from a wide range of relevant activities.

>> *An Interlude on Overlap*

We have reached a good point to explore the problem of overlap between kinds of thinking. Creative and critical thinking make a good case in point. Creative thinking virtually always involves critical thinking in formulating the goal and refining it, selecting among alternative approaches, refining candidate solutions, etc. Likewise, creative thinking makes an important contribution to

critical thinking, for instance, in generating reasons. Why, then, separate out a category for creative thinking? Basically, although critical thinking draws upon creative thinking, it often does not seem *prototypically* creative because it has its own target and characteristic challenges. Good critical thinking often does not yield complex, original products, nor is it necessarily supposed to. Likewise, good creative thinking, although it always involves subepisodes of critical thinking, typically does not yield as its main product a critical assessment of a belief or course of action.

This sort of relationship between critical and creative thinking also applies to the other categories discussed in this and the subsequent sections. For example, both critical and creative thinking clearly have a role to play in learning for understanding and the active use of knowledge. The more the learner critically assesses and creatively elaborates new material, the more the material is understood and primed for active use. At the same time, critical and creative thinking often require getting new information, understanding it, and actively using it. Nonetheless, learning for understanding and the active use of knowledge is an enterprise with its own target, characteristic challenges, and so on.

To speak in general terms, each kind of thinking is used by the others—each occurs, paradoxically, "inside" all the others. But there are distinctions concerning the "top level agendas" of the kinds of thinking: for creative thinking, the production of effective original products; for critical thinking, the evaluation of beliefs and courses of action, and so on. The "top level agenda," discussed under the label "target," brings with it certain characteristic challenges, strategies, attitudes, and subskills, even though all forms of thinking contribute somewhat to all others.

Some More Specialized Kinds of Thinking

We continue our discussion of kinds of thinking by examining three somewhat more specialized kinds of thinking activities that have importance in everyday and classroom activities. These kinds of thinking inevitably blend aspects of the larger categories

of critical and creative thinking and learning. Nonetheless, they have their distinctive aspects.

>> *Decision making*

Target. The prototypical target of decision making is what might be called a "decision point." You recognize that you have some choices in a situation, and you need to determine which path to take. This involves exploring the options, examining reasons for the options, and evaluating the reasons to yield a best choice.

Challenges. One challenge of good decision making is a thorough and creative survey of options. There is a tendency to make decisions based on the obvious options—one simply chooses between them. But very often there are other options not so obvious that offer the best resolution. Another challenge is to examine objectively the pros and cons of options. Usually, one option emerges as an early favorite; intuitively, it seems right. However, a careful enumeration of consequences, costs, and so on, not infrequently recommends another option altogether. A third challenge reflects confusion about what counts as a reason. Many people believe that personal feelings—"I don't like the sound of that job," or "This house we might buy just doesn't feel comfortable to me"—are not part of rational decision making. This, of course, is a misconception. Personal feelings are perfectly legitimate pros or cons in many, although not all, contexts of decision making. There are other challenges as well, but these three provide a good sample of the problems involved in decision making.

Helpful strategies and attitudes. The challenges outlined above point to some straightforward strategies for the process of better decision making:

- explore options thoroughly;
- for options that seem promising, examine the pros and cons thoroughly;
- include personal feelings as reasons where appropriate, and so on.

Table 3.1. Decision-making Issues and Components

CHALLENGES	*HELPFUL STRATEGIES AND ATTITUDES*
To be willing to survey options thoroughly and creatively	Explore options thoroughly
To recognize promising options	Examine the pros and cons of options
To avoid confusion about what counts as a reason	Allowing "heart" as well as "head" reasons to count, when appropriate
To maintain a sense of responsibility for self and others	Retain the feeling that decisions matter a lot because they shape people's lives

Of course, in special circumstances decision making strategies can become highly technical, using, for example, "payoff matrices" that organize exactly what gains or losses can be expected in different circumstances. As an example of attitudes, educators should promote in student decision makers a sense of responsibility for themselves and others—the feeling that decisions matter and matter a lot because they shape people's lives.

Subskills. There are many subskills involved in decision making. Among them are:

- generating options that may not have been seen at first;
- making well-founded predictions of consequences;
- generating reasons for or against options;
- strategies of fluent and flexible thinking (discussed under "creative thinking");
- integrating the information from several options individually evaluated into a final decision; and
- in complicated situations, weighting reasons and "scoring" options with the help of tabular layouts on paper.

>> *Everyday problem solving*

Target. Everyday problem solving refers to problems outside the formal context of math and science, problems with a "common sense" character. For example, your cat Tabby has hidden under the porch; how to get her out? There is a labor dispute; how to resolve it equitably? You have an essay assignment with free choice of topic; how can you find a good topic? Napoleon wanted to conquer Russia; in the end he invaded during the winter—a bad move—but what else might he have done? How could Hamlet have solved his dilemma? In general, the aim is to solve or resolve the problem.

It's reasonable to ask how this really differs from decision making, and indeed the two overlap considerably. Certainly decisions are often problematic and problems always require decisions of some sort. However, for a rough distinction, decision making begins with a decision point, where you see yourself as having at least two specific options, although you may search for more. Problem solving, in contrast, begins with a gap: you have a problem situation but you have no idea yet what your reasonable options are. You have to find them.

It's also reasonable to ask how everyday problem solving differs from creative thinking in general. It might be considered a

Table 3.2. Strategies and Attitudes Involved in Problem Solving

1. Do not settle for the first plan that presents itself.
2. Search vigorously for alternatives.
3. Examine how you present the problem to yourself.
   a. Are there unnecessary assumptions?
   b. How else could the problem be conceived?
4. List possible solutions uncritically; then sift them.
5. Carefully make a comparative evaluation of alternatives (consider consequences and costs).
6. Maintain attitudes of
   a. Perseverance
   b. Playful exploration
7. Apply subskills of creative thinking.

subcase—one where you encounter a problem with an everyday character. After all, considerable creative thinking has to do not simply with solving problem but with discovering and taking opportunities

Challenges. As the foregoing suggests, the principle challenge in everyday problem solving is the creative thinking challenge of finding good solution ideas. You begin in a vacuum and have to fill it. One particular hazard is "premature closure": often people seize on the first vaguely reasonable idea that suggests itself when a more extensive search would yield something better. Another particular hazard is proceeding with too narrow a concept of the problem. Often people make tacit assumptions that prevent them from thinking of innovative solutions by excluding those

solutions from the outset. For example, in the "cat under the house problem," you might assume that you have to get Tabby out, perhaps because you're leaving on a brief trip. What if you didn't retrieve Tabby? What if you left food out instead? How would Tabby fare? Whether a "leave Tabby alone" solution would work needs to be evaluated, but at least you have opened up options that would not otherwise have been considered

Strategies and attitudes. Again, the challenges outlined above fairly directly suggest some relevant strategies. One should search vigorously for alternatives rather than taking the first plan that comes along. One should examine how one is describing the problem to oneself: what assumptions are made unnecessarily; how else could the problem be conceived? Often it's useful to list possible solutions uncritically, to keep up the flow, and then go back and sift them. As in decision making, a careful comparative evaluation of alternatives, considering consequences and costs, is a good idea. And so on. Regarding attitudes, an attitude of perseverance is especially important. Many people tend to collapse in the face of a problem for which they do not see an immediate solution; they simply stop thinking. An attitude of playful exploration is often helpful in finding innovative solutions.

Subskills. Since everyday problem solving can be seen as a subcategory of creative thinking, subskills of fluent and flexible thinking and other subskills relevant to creative thinking are straightforwardly relevant here as well. Similarly, a variety of critical thinking subskills are important, especially in defining the problem and choosing the best solution.

>> *Problem solving in math and science*

Target. As the name of this category suggests, the target here is the resolution of problems in math and science. Typical textbook word problems present the paradigm case, although it's important in general to open up problem solving in math and science to make room for less "convergent" problems and indeed for students to formulate their own problems.

Challenges. We separate problem solving in math and science from everyday problem solving because the former implicates a number of factors not found in the latter. For one, problem solving in math and science usually is mediated by a formal notation—algebra, logic, the "two columns" format of Euclidean geometry. Many students have difficulty managing the formalism with flexibility and precision. For another, research shows that many students do not really understand the underlying concepts of these subjects even when they can handle the notation well. For example, in physics the distinctions between weight and mass, mass and density, and pressure and force commonly confuse students. Students tend to try to solve problems by turning the crank of equations, and need to be led toward qualitative understandings of problems that disclose their underlying structure. All this, admittedly, is a tall order.

Strategies. One key strategy is for students to be sure they understand the underlying concepts through, for instance, generating their own illustrations and exercises. Problem solving strategies *per se* are not going to be much help unless the conceptual base is there. As to problem solving strategies in themselves, research argues that problem management is important. Students need to explore the problem initially to be sure they understand what is asked for—often problems are misread or misinterpreted. Then they need to generate approaches, and having found an approach, monitor progress on it. Many students perseverate in an approach even when it is not paying off; they should ask themselves periodically whether progress is occurring and, if not, what other approach might be tried. Specific problem-solving heuristics can be helpful: Have I seen a problem like this before? How did I solve that one, and can I approach this one similarly? Can I represent the problem differently—in words, in diagrams, in a table? Can I solve a special case of the problem? But, again, such tactics are not likely to help unless the students have some understanding of the underlying concepts.

Concerning attitudes, the main challenge is perhaps overcoming the negative attitudes that many students have accumulated through a history of failure. Students should, of course, be encouraged in an attitude of interest and inquiry. But this is not likely to succeed if the students continue to fail. Manageable problems that can be solved with understanding, not by rote, need to be provided. Group work can dilute a sense of impotence and provide the courage of numbers. Less textbookish, more colorful, or real-world problems can help to restore some enthusiasm for the subject matter.

Subskills. Problem solving in math and the sciences, of course, involves the usual array of subskills characteristic of problem solving—generating approaches, and so on. However, it also involves a variety of technical subskills; for instance, drawing graphs and manipulating algebraic expressions. The temptation is to develop these subskills prior to substantive problem solving so that the student will have them in hand. Unfortunately, "technical skills first, real problem solving later" tends to make the technical skills look pointless and to yield inert knowledge. More powerful are problem-based learning approaches, where technical skills are introduced in the context of meaningful problems to be solved. Admittedly, it is not easy to organize instruction that way when most textbooks take the opposite tack, but it can be done.

Metacognition: a Superordinate Kind Of Thinking to Encourage

Metacognition, the last category of thinking to be discussed, deserves a section all its own because it has a special status. It is a crosscutting superordinate kind of thinking relevant to all the others. *In particular, metacognition refers to one's knowledge about, awareness of, and control over one's own mind and thinking*. For instance, to know a particular thinking strategy is to have a piece of metacognitive knowledge: you know that such and such a strategy will help to get a certain job of thinking done. While just having a particular attitude does not constitute

metacognitive knowledge, awareness that you have this attitude does. Awareness of your mental strengths and weaknesses is metacognitive knowledge. Attention to your thinking process before, during, or after an episode of thinking is a metacognitive activity.

As these examples make plain, we have already been talking about metacognition in examining awareness, attitudes, strategies, and related matters. Why, then, treat metacognition separately at all rather than just consider it covered by the foregoing discussion? Because metacognition has a higher order character not yoked to any one kind of thinking, and because one can distinguish several levels of metacognition as a way of gauging the sophistication of thinking in any area.

In particular, with any kind of thinking, we distinguish four levels of thought that are increasingly metacognitive.

- *Tacit use*. The individual does a kind of thinking—say decision making—without thinking about it.
- *Aware use*. The individual does that kind of thinking conscious *that* and *when* he or she is doing so.
- *Strategic use*. The individual organizes his or her thinking by way of particular conscious strategies that enhance its efficacy.
- *Reflective use*. The individual reflects upon his or her thinking before and after—or even in the middle of—the process, pondering how to proceed and how to improve.

We can see the importance of these distinctions by working through an example. Consider a subskill in decision making: generating options. You might want to do this in finding possibilities for party plans, essay topics, birthday gifts, and so on. We all *tacitly* use such a skill; we have to, because life routinely demands option finding. *Aware* use of option finding, however,

means more than just thinking of possibilities when you need to. In aware use, you are aware that and when you are generating options. This is valuable in the development of thinking for several reasons. It helps you to see what role option finding plays in your overall pattern of thinking. It may also help you to recognize when you need to seek options; through awareness, you are likely to find occasions where you tend to follow your first impulse but should not. It may help you to focus attention and increase effort: knowing that you are generating possibilities, you may stick to the task better.

To continue up the ladder of metacognition, *strategic* use of option finding means that you are consciously directing your thinking, deploying strategies in order to generate more and better possibilities. There are many such strategies for option finding: for instance, the classic brainstorming tactic of deferring criticism and closure, allowing wild ideas, tacking one idea onto another, and sifting the pool of ideas later. Strategies are important to the development of thinking for reasons we have already discussed.

Finally, *reflective* use of option finding goes beyond strategic use. You might deploy an option finding strategy as a matter of habit, with little thought about why to do it that way or how well the strategy works. However, if reflective, you ponder in advance how to approach a particular task. You ask yourself afterward, "How did it go? Did the strategy serve well? How else could I approach this." You may interrupt yourself midstream, asking, "Is this really going well? Am I on track? Should I switch strategies?" As such questions suggest, reflective use is the key to improving one's own thinking through revising and extending one's strategic repertoire.

All this should make the reason for our emphasis on metacognition clear. Well-designed instruction should encourage students to become metacognitive because this puts them in charge of their own thinking. Through reflection, they can probe and assess, revise and test, their own thinking processes. This will promote

further autonomous development of thinking beyond the range of the immediate instruction.

Section Summary

Perhaps metacognition and the categories discussed in the previous section will provide a sense of the variety and character of important kinds of thinking. We also believe that these categories encompass a large percentage of the sorts of thinking worth teaching. However, certainly the scheme is not all inclusive. To underscore that point, let us add that nothing direct has been said about such important kinds of thinking as planning, scientific reasoning, categorization and classification, and higher order writing or reading skills. Each of these presents possibilities for classroom use that would enhance students' thinking. To be sure, one could make a case for these kinds of thinking fitting as subcategories into some of those categories already suggested. For example, planning might be viewed as a particular sort of problem solving, scientific reasoning as a kind of critical thinking, and higher order reading skills as a particular sort of learning with understanding. Nonetheless, each of these additional examples brings with it special considerations about target, challenges, strategies, attitudes, and subskills that indicate some distinctness.

The basic point is this. By and large, we think it most useful to organize efforts to teach thinking under categories with a relatively broad and familiar character, such as those elaborated earlier or the additional ones just listed. In addition, we must all be open to other categories not mentioned here. However, this does not mean that any framework of categories will do as well as any other. Indeed, it is worth a moment to consider two well-known approaches to defining kinds of thinking that are problematic.

Two Problematic Frameworks for Kinds of Thinking

>> *Right brain—left brain*

Perhaps the most sweeping classification drawn in contemporary talk about the teaching of thinking is the popular contrast between left brain and right brain abilities. Broadly speaking,

left brain abilities refer to language, logic, systematicity, convergent thinking, analysis, and the like, while right brain abilities refer to the visual, imaginative, exploratory, holistic, playful, etc. The basis for sorting such characteristics of mind into the left and right brains comes from research locating linguistic capacities in the left brain in right-handed people and revealing certain other interesting contrasts in the function of the cerebral hemispheres. The left brain-right brain contrast has become a kind of banner under which some concerned educators have campaigned for more attention to creativity, visual thinking, and so on, urging that education proceeds in a doggedly left brained fashion, systematically neglecting right brain abilities.

Hazard: A lack of substance and guidance. We certainly applaud attention to the abilities people link to the right brain; they do not receive the attention they should. At the same time, it must be said that formulating what needs to be done in the language of left and right brain abilities suffers from some serious problems. First of all, conventional schooling neglects *higher order* left brain abilities as much as right brain abilities. For instance, how much real attention is paid in classrooms to general linguistically mediated reasoning or logic? Second, although the spirit of the left brain-right brain distinction between abilities seems clear enough, in detail there is a logical muddle. How do poets write poetry, for instance, since language resides on one side of the brain and creativity on the other? How do we read, since language resides on one side but visual pattern recognition on the other?

Third, the technical research on hemispheric function does not at all justify the sweeping allocation of abilities like creativity or critical thinking to one or the other side. Instead, it suggests that almost all substantive activities involve complex cooperation between the hemispheres. Fourth and finally, how does the right brain-left brain distinction, even if sound, help us to *teach* thinking? What strategies should we convey, what attitudes impart, what awareness encourage? The distinction is so nonspecific that it provides no guide for specific action.

Help: Avoid the notion. Intriguing though the right brain-left brain notion is, we suggest that it not be used as the philosophical basis for developing students' thinking. There simply is not enough substance to the distinction.

>> Bloom's taxonomy

Most practitioners have at one time or another encountered the taxonomy of Benjamin Bloom, an effort to sort out levels of skill involved in thinking and to promote attention to them. Bloom distinguishes six levels of skill: knowledge, comprehension, application, analysis, synthesis, and evaluation. According to Bloom, the skills become increasingly sophisticated as one goes from knowledge to evaluation. Considerable research has demonstrated that nearly all the questions students are asked in classrooms K–12 fall into the first or the first two categories. "What" questions typify these, whereas "why," "how," and "what-if" questions, used to prompt what have come to be called higher order thinking skills, receive little attention. These sorts of questions tend to fall into Bloom's last four categories.

Hazard: Total Bloom. Sometimes Bloom's taxonomy is used as the sole basis for a thinking skills program. The aim is to promote the higher order skills on the Bloom scale. Here it's important to recognize that Bloom's categories have come under some criticism as too broad, vague, and overlapping to provide a foundation for focussed instruction in thinking. In terms of a distinction made later in this section, its levels tend to "float," and, indeed, two of Bloom's levels, "analysis" and "synthesis," will be used to illustrate the problem of "floating" categories of thinking. Moreover, Bloom's taxonomy in itself gives no information about how to help students at these levels. What strategies do you teach, attitudes cultivate, and so on? In sum, a thinking skills program that only aims at asking higher order questions on the Bloom taxonomy is, in our view, not grappling with the real challenge of developing students' thinking.

Help: Bloom as a part. There is nothing wrong with higher order questioning, as far as it goes. Bloom's taxonomy can pro-

vide a reasonable guide to reframing classroom interactions and refocussing instruction generally so that it addresses a richer range of intellectual tasks. For instance, it can be used as a lever to push instruction away from primarily fact-based questioning of students. Given the range of considerations outlined earlier, though, Bloom's taxonomy should always be only a part of a more extensive plan, and never an excuse to say "we've done it—we're teaching thinking."

Helps and Hazards about What Kinds of Thinking to Teach

>> *Cornucopia*

Critical thinking, creative thinking, learning with understanding, decision making, everyday and technical problem solving, metacognition, the matters of right brain–left brain and Bloom's taxonomy—the discussions to this point comprise a general perspective on kinds of thinking to teach. Turning to the challenges of classroom practice, it is useful to offer another "helps and hazards" section like that in the previous chapter. Here we examine some of the hazards typically encountered when one tries to sort out what kinds of thinking ought to be taught in a particular setting, along with some counsel about how to deal with those hazards.

Hazard: Too many options. One of the simplest hazards in deciding what kinds of thinking to teach is the paralysis of diversity. Consider the six categories of thinking discussed in the previous two sections. All appear transparently important. All have evident relevance both to schooling and to life outside and after schooling. Nor does any logic of precedence apply. Someone might argue, for instance, that since you have to learn before you can do anything else, strategies for learning with understanding must come first. However, the point was made that creative and critical thinking can be used to promote effective learning, which means that they come first. In reality, all the kinds of

thinking discussed have a "which came first—the chicken or the egg" relationship to one another.

Help: Choose what suits you and your circumstances. Given the manifest importance of so many kinds of thinking, it's wisest to accept this as one of those situations where you have to choose on other grounds than "official best." Consider your classroom or school system. Ponder what your students might need and enjoy most. Probe the needs of your subject matter and your own interests and enthusiasms. Contemplate what you can handle comfortably. Choose—from the categories we have discussed or some others—something that appeals. We see no harm even in picking somewhat arbitrarily a couple of important kinds of thinking for focused attention. In the long run, of course, education should foster students' development across the spectrum of kinds of thinking.

>> Number of skills

Hazard: Too many skills. Sometimes approaches to the teaching of thinking adopt long lists of skills to impart to students. This certainly is understandable: thinking is a complex multifaceted enterprise. For example, each of the kinds of thinking just discussed can be elaborated into long lists of subskills that might help in various circumstances. While one must acknowledge this complexity, in practical terms long lists almost always cause trouble. It becomes nearly impossible to do anything well, because there is too much to do. Also, with so many subskills to get through, there's a high risk that little will be done to put them all together into the overall thinking activity, which, after all, is what we're seeking. Finally, long lists of skills often distract from attention to relevant thinking attitudes, metacognitive awareness, and other factors that are very important to the development of thinking.

Help: prefer depth to breadth. How to help with this problem seems obvious: avoid large sets of skills. In building an approach for a year of instruction in one's own classroom, one is well advised to select two or three major kinds of thinking,

with a few major strategies, attitudes, skills, and so on, for each. These can then be developed with some thoroughness.

For example, a fourth grade teacher might choose *decision making* as a kind of thinking to start with, and set as one goal helping students organize their thinking in making decisions by using the strategy of considering options first, and then the pros and cons of each. She might use children's stories read in the fourth grade, and/or some activities in elementary science, as the vehicles for this instruction. Then, she might go into greater depth by selecting certain creative thinking skills used in generating options, introducing them to techniques like brainstorming in the process. In addition, she could also concentrate on the critical thinking skills needed to make well-founded predictions, as they are used in thinking about the pros and cons of the options being considered. And all of this might be done with an emphasis on attitudes of open-mindedness and the need for reasons for our choices.

Of course, for a program that covers two or three years, more can be attempted. What she does, of course, might be part of an organized school (or school system) wide program that stresses depth of this sort at the classroom level and achieves breadth as well *across* different classrooms and grade levels.

>> Structure of lists of skills

Hazard: Sloppy structure. Many of the numerous efforts to organize the teaching of thinking around a list of skills suffer from blatant structural problems. It is commonplace, for example, to find lists in which one skill obviously is a special case of another, yet the two are listed as separate skills. For instance, you may discover a list that includes inference and prediction as separate skills; yet by definition prediction is a special case of inference.

Another common structural fault occurs when activities said to address a particular skill do not show any more special link to that skill than others on the list. For instance, instruction in reasoning might offer activities in (a) assessing evidence and (b) inferring

from evidence. However, in a particular example meant to illustrate or provide practice in inferring from evidence, the given evidence seems highly suspect and demands assessing. Of course, examples meant to address both (a) and (b) at once are fine, but an example should not be identified as especially appropriate to one when it speaks to both equally.

Yet another structural problem occurs when a list of skills representing a certain kind of thinking has blatant gaps. For example, some approaches to improving reasoning may highlight only inference from given evidence but neglect the matter of assessing evidence: Are there risks of observer bias? Were conditions of observation good? (Or, for statistically reported evidence, is there any potential for averages or other statistical concepts being misleading?) Reasoning in any reasonable sense is not well served by a list of skills that neglects assessment of evidence.

Help: Structural standards. In general, lists of skills should not just have one level, but should include subcategories that group the skills and show their relatedness. One skill should not contain another unless the subcategory organization shows that to be the case. Skills on the list at the same level should not overlap greatly, although we have to remember the point stressed earlier that inevitably categories of thinking tend to overlap somewhat. The skills listed for a given type of thinking should cover fairly well that type of thinking. Examples and exercises said to address a certain skill specifically should actually do so. These points seem obvious, but in fact they need to be monitored constantly. Many efforts to organize instruction around lists of skills blatantly violate fundamental matters of reasonable structure. When one finds problems, one should repair them or seek another more carefully crafted list of skills.

In addition, it is important to remember here a point emphasized in the "helps and hazards" section earlier in this chapter:

Table 3.3. Structural Standards for Lists of Skills

1. Lists of skills, in general, should have more than one level. These should group the skills and show their relatedness.
2. One skill should not contain another unless indicated in the subcategory organization.
3. Skills on the list at the same level should not overlap greatly.
4. The skills listed for a given type of thinking should cover fairly well that type of thinking.
5. Examples and exercises said to address a certain skill specifically should actually do so.

just teaching for skills is not enough. One has to develop attitudes, awareness, and other factors that foster students' thinking.

>> *General versus subject-matter specific kinds of thinking*

The goal of general versus subject-matter-specific kinds of thinking has become an issue in the field over the last several years. Considerable research evidence has shown that expert thinking in a subject-matter is rather context-specific. Investigations of expertise in such areas as chess play, social science, computer programming, and mathematical problem solving have disclosed that experts benefit from a rich repertoire of knowledge

and tactics quite special to the discipline. Very general strategies of thinking simply do not equip a learner in the same way that this repertoire does. Nothing counts like experience, one might say. A few scholars have even been impressed sufficiently by these research findings and other sources of evidence to argue that efforts to improve very general kinds of thinking such as creative thinking, critical thinking, or problem solving offer hardly any benefits at all.

But before despair sets in, let us say that in our view this is a hasty and misleading conclusion. First of all, even if one cannot improve, say, problem solving in general, that is not the end of the enterprise of teaching thinking. One could seek to improve mathematical problem solving, physics problem solving, problem solving in history, and so on. *Moreover, it seems clear that there are at least some general and powerful kinds of thinking.* A number of chronic and generic problems plague human thinking. People tend toward premature closure, under exploration of the other side of the case, oversimplification of situations, and various other well-known pitfalls of thinking. Although habits of mind that evaded such pitfalls would not make one an instant expert chess player or theorem prover, such habits would seem to parry the sorts of general lapses that impair thinking wherever it occurs—within academic disciplines or in everyday life.

Furthermore, even though perhaps there is no substitute for experience, it is important to recognize that much of the thinking we do occurs in contexts where we *cannot* have extensive experience. First of all, people deal with such a variety of problems that they cannot expect to become experts in all of them. Second, even in domains where a person ultimately will become an expert, there is a long learning period to pass through. A sound foundation in good thinking practices should help the person to handle better that learning period.

Being aware of these points, one might sum up the matter as we do in the following paragraphs.

Hazard: grand expectations. Often, approaches to developing very broad and general aspects of thinking are undertaken with *the hope of a strong impact on highly technical kinds of thinking*, such as mathematical problem solving. While sometimes a modest impact may occur, the specialized demands of particular disciplines imply that a strong impact is unlikely without targeted instruction. On the other hand, often programs to improve thinking in a particular discipline are implemented with the hope that the effects will spread far and wide, improving thinking generally. For instance, Latin, mathematical problem solving, formal logic, and computer programming are four disciplines from which strong ripple effects have been expected. Of course, such a tight focus is most likely to build up thinking abilities directed at the disciplines in question, with slight if any ripple effects. Research confirms this. As we emphasized earlier, to obtain transfer from a specific context, one has to teach for transfer, "decontextualizing" the discipline-specific thinking, thus bridging from the learning context to other contexts in ways that make the wider import clear.

Whether one is developing a general approach and expecting big payoffs in particular subject matters, or developing a focussed approach and expecting large ripple effects, the same consequences are likely: disappointed hopes and perhaps the counter-productive conclusion that students' thinking cannot be improved substantially after all.

Help: Clear policy and reasonable expectations. First of all, it's important that planners of instruction clarify their objectives and methods. Ideally, one might like to enhance *both* general and subject-matter specific kinds of thinking. A multi-level approach can do so since, of course, subject-matter specific kinds of thinking are special cases, with their own requirements and rewards, of more general categories. For example, as we emphasized earlier, problem solving in math and the sciences, while having its own characteristics, also draws on considerations relevant to everyday problem solving. Thus, for instance, a math

teacher might choose to devote significant class time both to math-specific aspects of problem solving and to some important general characteristics, with transfer activities. Alternatively, a teacher teaching a separate thinking course, after dealing with some general aspects of problem solving, might choose to teach a unit on mathematical problem solving.

However, resources and priorities do not always allow a full-spectrum approach. If a selection or choice of emphasis has to be made, it should be made mindfully. For instance, would you prefer to invest in math problem solving, without expecting sizable ripple effects beyond that, or in problem solving in general, without expecting a big impact on students' math problem solving? We certainly do not want to offer any sweeping answer to such choices because we think that the answers must be worked out case by case, considering the priorities of the people and institutions involved. We urge only that a couple of principles be respected: First, decisions should be taken thoughtfully and expectations tuned to accord with the decisions. Second, in our view, such decisions ought to reflect a broad conception of good thinking that in principle applies across the curriculum, even if only parts of that conception are played out in particular subject matters for the time being. Efforts of limited scope today may grow into broader enterprises in the years to come, a process made easier if the vision is broad from the first.

In Conclusion

Throughout chapters two and three, we have tried to characterize broadly the prospects of education that develop students' thinking, exploring the ways thinking might improve and the kinds of thinking that education could address. On the whole, we feel that the emergent picture is very encouraging. While plenty of research remains to be done, useful educational action can be taken today. What practitioners might do concretely to mount practical programs is the theme of our next chapters.

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CHAPTER FOUR

INFUSING TEACHING THINKING INTO REGULAR SUBJECT-AREA INSTRUCTION

Kevin O'Reilly, a high school American history teacher from the Hamilton-Wenham School system in Massachusetts, starts his lessons about the reliability of sources of information in history by staging a scuffle in the corridors outside his classroom. He then tries to ascertain what happened by asking students who were in the vicinity. The differences in the accounts his students give are like the variety of accounts that were given about who fired first in the Revolutionary War at the Battle of Lexington (Massachusetts) in 1775. The attempts by these students to determine which of the eyewitnesses to the battle gave the most accurate account, and their reflections on why one account is better or worse than another, arm them with certain critical skills that they draw on again and again in Kevin's classroom. In the immediate context of their study of the Revolutionary War, these skills put Kevin's students in an excellent position to make informed critical judgments of the accuracy of various textbook accounts of these incidents that other students in other classrooms are directed to read simply to "get the facts."

These skills are, of course, important not only in the study of history. They are also important in ascertaining the credibility of a vast amount of "information" passed to us through a variety of sources in everyday situations, usually through the media. Kevin tries to teach so that these skills will not only be helpful in reading history, but also in this broader arena of the everyday lives of his

students: he tries to help them *transfer* these skills out of his immediate classroom setting into their everyday thinking.

Kevin's strategy represents one approach to bringing teaching for thinking into the classroom. He uses traditional materials such as textbooks, and teaches about traditional content like the Revolutionary War, but, he *restructures* the way these materials are used and this content is taught so that students will develop specific critical thinking skills judged to be of importance both in and outside the subject of instruction. There are, in fact, a number of critical thinking skills that Kevin teaches in his American history classes in this way..

In this chapter we will look at how lessons can be structured in subject-area instruction to help students develop, use, and integrate the ingredients of thinking in both their academic and nonacademic lives. We call this approach to teaching thinking *infusing teaching for thinking into regular classroom instruction by restructuring the way traditional curriculum materials are used.* This approach contrasts with another approach focused on bringing teaching thinking into a school, which we will discuss in the next chapter of this book. The latter involves relying solely on a special program or course to teach thinking—one that is offered in addition to and separately from regular subject-area courses.

We have chosen for comment in this chapter particular examples of infused thinking skill lessons. The reason for this selection is to provide state-of-the-art models as guidance for teachers who similarly want to restructure what they teach in order to teach for these skills. We are sensitive to the fact that many other teachers do things in their classrooms that they also view as infusing teaching for critical thinking. What we would urge is that even if you already teach to stimulate critical thinking, you still examine what you are doing in the light of the features to which we call attention in the following lessons. Where you don't yet

incorporate some of these features in your classroom activities, we would urge that you try.

Restructuring Curriculum Materials To Teach Thinking Skills

It will be worth looking in a little more depth at the American History lesson upon which we commented at the beginning of this chapter. The heart of this lesson involves Kevin O'Reilly's students in a consideration of the accuracy of various eyewitness accounts of the opening shots in the Battle of Lexington (1775). The students turn to the eyewitness accounts after finding that historians disagree about who fired the first shot.

Kevin sometimes begins this lesson by asking his students to read a passage like this, taken from a typical American history textbook (Steinberg, 1963):

> In April, 1775, General Gage, the military governor of Massachusetts, sent out a body of troops to take possession of military stores at Concord, a short distance from Boston. At Lexington, a handful of "embattled farmers," who had been tipped off by Paul Revere, barred the way. The "rebels" were ordered to disperse. They stood their ground. The English fired a volley of shots that killed eight patriots. It was not long before the swift-riding Paul Revere spread the news of this new atrocity to the neighboring colonies. The patriots of all New England, although still a handful, were now ready to fight the English. Even in faraway North Carolina patriots organized to resist them."

In other classrooms, students reading a passage like this one would read it for the facts, and their main motivation would be to pass tests in which they are asked to give back these "facts." Simple recall is the dominant mode of thinking in which these students would be engaging. Kevin, on the other hand, prompts his students to stand back from this passage and give it a careful critical look. He prompts this by contrasting it with others which

give a different account and which do not contain slanted language that uses words like "atrocity" and "patriot." Winston Churchill, for example, in the *History of the English Speaking Peoples* claims that the Colonists fired first and that the British merely returned the fire. Whom should they believe? And how can they make this decision?

Kevin's students are quick to suggest that someone who was there might give us a more accurate account. In anticipation of this, Kevin has available a number of eyewitness accounts. He challenges his students to consider *their* accuracy. They consider the location of the witnesses at the time; what they were doing; their sympathies; when their accounts were given, and so on. The reflections that Kevin builds into this lesson about the factors that count in general for reliability and for unreliability, and the importance of ascertaining whether these factors are present in both secondary and primary source material, cap off a rich thinking oriented activity for his students. Such critical thinking rarely goes on in high school American history classrooms.

It is important to note the available versatility in restructuring the use of standard curriculum materials to bring teaching for thinking into a classroom. A first-grade teacher in the Provincetown Elementary School in Massachusetts, for example, uses the same technique to focus on the same skills as Kevin at her grade level. To do this she follows up a reading of the tale of Chicken Little with a discussion, prompted by her questioning, of whether the other animals should have trusted Chicken Little, and how they could have determined her reliability. She also asks them whether the eventual decision of a whole group of animals that the sky is falling makes Chicken Little more believable than when she is alone in her conviction. What factors would make the group's claim more compelling than Chicken Little's alone?

In restructuring the use of the Chicken Little story with the goal of integrating teaching for the same critical thinking skills that Kevin works into his discussion of the Battle of Lexington, this teacher, of course, organizes her teaching in a grade-appropriate

way using grade-appropriate materials. By contrast, other teachers who do not use the story of Chicken Little to teach for thinking may have as their goals in teaching this story simply helping students to develop listening skills and to learn some new vocabulary. These goals can all be accomplished along with the thinking skill goals that this particular teacher included.

Cathy Skowron and Sandra Bostwick, the teachers who constructed these activities for use with the story of Chicken Little, were also interested in another set of critical thinking skills. These relate to the use of evidence in inference about cause and effect. This focused the attention of her students on Chicken Little's *own judgment* that the sky is falling. Chicken Little's judgment is typical of a great many judgments we make in our own lives—it is the conclusion of an inference from something we identify as an effect to a cause which, we feel, explains the effect. Relying on good evidence to support causal explanations ought to be a central feature of our everyday experience. It often isn't. It is crucial in many cases in our lives that we do the best we can in reasoning about what caused what: good causal explanation of things that happen can help us either to prevent them or to bring them about in the future, depending on whether they are desirable or undesirable. The Chicken Little story parodies some of the dangers of not being so careful. Cathy's activities with her students help them to counter the tendency we have to be as careless as Chicken Little in our causal explanations.

Cathy promotes the development of good thinking skills about causal inference by asking her first grade students a number of key questions to prompt their focussed thinking. Did Chicken Little have good reason for thinking that a piece of the sky hit her on the head? What evidence did she have? Could something other than the sky have hit her on the head? Can we list some possibilities? How could we find out which possibility from among those we can come up with actually caused the bump on her head? What might we find that *counts in favor of*, and *against*, each of these possibilities? These questions posed by Cathy Skowron prompt

her students to think about this question using an organized strategy of the sort that we discussed in chapter 2.

Cathy usually ends this activity by helping her students connect their thinking about Chicken Little with their own experience. This, she feels, is an initial step that may help students transfer the kind of thinking they have just done into the thinking they do outside the classroom. She asks, for example, "Can you remember any times when you thought something caused something else, but you were hasty and jumped to the wrong conclusion? What could you have done to really find out the cause?"

This thinking activity is directed at making a reasonable judgment about the identity of the likely cause of something. It is typical of inferential activities involving the use of *evidence* in which we draw conclusions based on that evidence. In it Cathy stresses the organization of the students' thinking as well as the use of specific sub-skills in this organization.

Cathy Skowron's students used, for example, sub-skills of critical thinking that relate to the relevance and strength of certain evidence to determine which of various possibilities are the most likely causes. These same sub-skills (and others) are basic to what many of us engage in when we undertake research to determine unknown causes of effects. For example, we often think first about what to look for as evidence before we start our investigations. When my car doesn't start and I don't know why, I might think that it could be the battery. I shouldn't, though, make the hasty judgment that it is the battery. Rather, I might consider that if the lights don't work, I will have some evidence that this causal explanation is correct. But I must be careful because this evidence is not strong enough—other possibilities, such as a broken wire, are also supported by it. So more evidence is needed if we are to judge as likely the hypothesis that the problem is with the battery.

Cathy *highlights* such nuances of thinking when she conducts these activities about Chicken Little with her students because she feels that it is important to avoid these pitfalls. One of the techniques she uses to highlight them is to identify them for her stu-

dents by categorizing them as involving "finding evidence." Here we have the beginnings of a *metacognitive* awareness of thinking structured into what Cathy does with this story.

Other sub-skills that are important in causal explanation could be highlighted in this lesson, too. Students, e.g., may have a hard time initially thinking in a more open-ended way, i.e., by being less judgmental and more imaginative in generating alternative explanations before passing critical judgment. Accordingly, a teacher may want to emphasize this kind of thinking by categorizing what they are doing as coming up with "possible causes." In this case the focus would be on what we have identified as *creative* thinking skills: skills related to generating ideas and oftentimes involving imaginative generation of unusual possibilities.

It is important to note that doing these different things involves using the same content but structuring activities connected with that content to highlight different thinking skills that relate to the material. A teacher need not highlight all of these in any given lesson, and may even choose to highlight one of these and not the others. In restructuring standard content to teach for thinking, any number of choices can be made. Teachers like Cathy Skowron usually make these choices based on what they think it will be important for the students to learn, given what can be done with the material.

All of the kinds of thinking we have discussed in chapter 3 can serve as the basis for such restructured uses of curriculum materials. In such restructuring for infusion, the three questions in Table 4.1 are important for each teacher to ask .Teachers who have adopted infusion as their approach for teaching thinking claim that there are ample opportunities in the curriculum we teach for lessons to be developed on all of the different forms of thinking we feel are important. But they stress the need to come to terms with the character of these forms of thinking—their organization and the nature of the important sub-skills involved before building such lessons. Let's now look at this process in more detail to see what implications it has for the way we

Table 4.1. Three Questions for the Teacher to Ask Him/Herself in Restructuring for Infusion

1. What are the details of the kind of thinking I want to help my students learn?
2. Where, in what I already teach, is there content that can be used for this sort of thinking?
3. How will I organize lessons in which I teach for this sort of thinking?

answer the question raised in (3) of Table 4.1 about the organization of these lessons.

How to Construct Lessons That Infuse Teaching Thinking Skills into Subject-area Instruction Through Restructuring Traditional Content

We will start this section by sharpening our look at the lessons we have just introduced. We have already mentioned a number of special features that both Kevin and Cathy employ in teaching thinking skills. These include techniques to make students aware of the thinking they are doing (metacognitive techniques), and varied practice using the same skill. These techniques build on a *core activity* in which students actively use the thinking skill that is the target of the lesson (e.g., when they are thinking about the eyewitensses to the Battle of Lexington or Chicken Little's bump on the head). In this section we will comment on the way the *core activity* in the lessons we have described is structured. This will be important as a prelude to our taking you through the construction of an activity of this sort in another infused lesson.

Even though Kevin and Cathy teach students eight grades apart, and the lessons they have developed are in different subject

areas, the way they try to teach their students the same skill is similar. There is a similar *structure* to the way they focus the attention—and the thinking—of their students. Kevin asks his students to look at various eyewitness reports, and then to think about what they could find out about the eyewitnesses and the circumstances of the reports that would be relevant to their reliability and accuracy. Cathy asks her students to suppose that they are Cocky-Locky and that they've just met Chicken Little, who says that the sky is falling. What could they find out about Chicken Little and what she says that would help them decide whether to believe her; i.e., is she a reliable source. Both of these teachers focus their students on factors that count for or against accuracy and reliability.

In Kevin's case, his students can move on to look for and gather relevant information on the basis of which they can make a reasonable judgment about the reliability of the reports. In Cathy's case her students, of course, cannot. But Cathy can at least simulate this by saying things like: "Now suppose you found that everyone said that Chicken Little says things she doesn't know all the time. What would that make you think about whether to believe her?" or "Suppose Chicken Little was a scientist?" Her students will then do the same sort of thinking that Kevin's do when they themselves find relevant information—such as the fact that one of the most compelling of the eyewitness reports unfortunately was given in 1826, fifty-one years after the incident the eyewitness was reporting on!

The structure of the thinking that goes into making well-founded judgments about the credibility of sources of information is easy to grasp. We do it ourselves—though perhaps not as much as we should. It involves resisting the temptation to believe something simply because someone says it; and then accepting it as credible or not accepting it as credible only after we find that there are factors that count strongly in favor of (or against) the reliability of the source. This occurs typically when we have no more direct way to access the information in question (e.g., our

own direct observation). Table 4.2 is intended to capture this. There, the "thinking map" provided serves as a guide for constructing activities to teach this skill, no matter what the content. The way Kevin and Cathy do this is to formulate a sequence of prompting questions that take students through this process of thinking in an organized way. Other techniques for using such thinking maps will be discussed in chapter 7.

Similarly, the structure of the thinking skill activity that Cathy takes her first grade students through on causal inference can be mapped explicitly. When she teaches this skill using the *Chicken Little* story, she asks them to role play Chicken Little herself, but to imagine that they are going to resist jumping to a conclusion and are going to do more careful thinking. She then prompts them to think about as many possible explanations as they can for what

Table 4.2. Thinking Map of the Reliability/Unreliability of Sources

To determine whether sources are reliable or unreliable,

1. list the factors present that are relevant to the reliability of the source:
   - corroboration
   - primary or secondary
   - expertise
   - bias or point of view
   - date recorded
   - proximity to event reported
   - attention
   - expectations, etc.
2. weigh the factors present and make a judgment of reliability based on these.

caused the bump on the head Chicken Little received, and to figure out how they could find out which of these was the real cause. After they've had some time to think this through, she says—as she does when they are considering Chicken Little's reliability as a source of information—"Suppose you found acorns on the ground, saw a squirrel in the tree you were under, and it was fall. What would that be evidence for?" Here her concern is to start them thinking naturally about *evidence* whenever an issue about what caused something comes up.

An instructional map of this skill that brings out this structure might look something like this (Table 4.3):

Table 4.3. Map of Causal Explanation

1. What are possible causes of the event in question?
2. What could you find that would count for and against the likelihood of these possibilities?
3. What evidence do you already have, or have you gathered, that is relevant to determining the cause?
4. Which possibility is rendered most likely, based on the evidence?

Now look at the following activity, used in fifth grade science, as the core activity of a thinking skill lesson, and you will see the same structure. This lesson was developed to teach the same critical thinking skill, causal explanation, but this time for

upper elementary school students in science. To begin the activity the teacher might say something like this to the class:

> "Scientists are not just interested in things like floods that happen today. They are also interested in major changes that happened to the earth a long time ago. One thing that has puzzled scientists for a long time is what happened to the dinosaurs at the end of the Mesazoic Era. No one knows why they became extinct, but it's worth thinking about *what could have caused their extinction and how we could find out.*"

The activity is then structured as a series of prompting questions and requests that might look like this (Barman *et al.*, 1989, reprinted by permission of Addison-Wesley Publishing Co.):

> 1. Dinosaurs lived for a very long time; there were lots of them, and even though they were huge animals, not one survives today. Some were plant eaters only, others ate meat and hunted other animals. List as many different possible ways that you can think of that things could have changed on the Earth to cause the Dinosaurs to become extinct.
>
> 2. Pick three of these and write a story about how these things could have happened in a way that killed the dinosaurs.
>
> 3. Suppose you were looking for clues about which of these three possibilities was what really happened. What sorts of things might you find today that could give you evidence in favor of each, and what could you find that would count against each?
>
> 4. Imagine that while looking for clues, you find the following things in various sedimentary rocks:
>
> - lots of dinosaur tracks at one level, fewer at another, and then none;
> - fossilized leaves and plants at one level, and then very few;
> - more mammal tracks and bones in some levels than in others.
>
> When you bring these to a laboratory for Carbon 14 dating, you find that the plants and leaves coincided with a lot of dinosaur tracks; then the layers with fewer plants came just before there were fewer

dinosaur tracks; and then there were no other dinosaur tracks. The increase in mammal bones came as the dinosaur tracks diminished.

In favor of what possible explanations does this evidence count?

Notice how the structure of this lesson turns on the specific questions being asked and their sequence. This, in turn, grows out of an awareness of the structure represented in the map of causal inference reproduced above.

If you want to help students become aware of and practice thinking skills related to causal inference applied to some other topic in a different subject area, it is not too difficult to formulate similar prompting questions that will lead them through the inference process. First, you must prompt them to generate an array of possible hypotheses. Then, being sensitive to the need for good evidence, you should help them, through questioning, to see which hypothesis stands out as the most reasonable explanation. You should be able to spot these questioning techniques in the dinosaur activity.

The subtleties of the activity are easy to understand against this map as well. Note the creative touch that is present when students are asked to write stories about possible ways that the extinction of the dinosaurs could have occurred. This helps them elaborate some of the possibilities, and allows for a more imaginative exploration of these possibilities than if they just listed them. But it also, in turn, helps them think of evidence they might find today that would have bearing on whether this is what really happened. Similarly, the detective-story-like set-up in this lesson is intentional. It is designed to make students seek and use evidence, and hence to feel motivated to move beyond this lesson and consider what real evidence there is about the extinction of the dinosaurs. When they consider the evidence given, they should figure out that it weighs in favor of the disappearance of the food supply of the plant-eaters. Then, perhaps, because the plant-eaters may have died off, the meat-eaters would have as well. But it is also somewhat sparse, leaving open a number of other possibili-

ties. Recognition of how inconclusive it is can spur them on to look further.

This kind of lesson contrasts with others that are called "cause/effect" lessons and that often are presented as critical thinking lessons falling under the category of "inference." Many of the latter simply have students *identify* given events—perhaps in a story they are reading— as causes or effects even though these events are identified this way already in the story. While these lessons help to sensitize students to thinking of events in terms of causes and effects, they will probably have little impact on helping students develop skills at generating hypotheses or gathering and using evidence to decide whether a possible explanation is a reasonable one. It is this skill that is extremely important to use well in any sort of research, as well as in everyday situations like finding that your car doesn't start.

This is what we mean when we stress the importance of being clear about the details of the kind of thinking we want to help students perform (Table 4.1). This does not mean just knowing the name of that thinking skill. Rather, it means understanding it's deeper structure, as the teachers whose lessons we are commenting upon have attempted.

Teachers who have constructed infused lessons to help students make better use of skills like these in their thinking have based their efforts on ideas about the skill that are sometimes not articulated in as much detail as this. How does a teacher know when he or she has articulated the skill well?

There is nothing presently available that provides comprehensive guidance for teachers on the character of these skills, although we are aware of some developmental work to make such comprehensive material available to teachers. Until such material becomes available, there are some things that can be used for partial assistance. A look at what other teachers have done to teach these skills—as we have done with these lessons— can be very instructive. There are also some textbooks that now attempt to infuse thinking skills. It also helps to look at the teacher's editions

of these books to gain a sense of how the skills are articulated. (We reproduce a page from one such book in chapter 8.) But teachers can also draw upon their own experience in using these skills. They can base the maps they develop of these skills on dissecting good examples of their proper use. In chapter 8 we discuss school based support structures that have been effectively used to provide a context for this crucial stage in the planning of thinking skills lessons. The use of peer coaching is an especially rich structure that many schools now employ.

These support structures are also important in providing a setting for a teacher to look through what he or she teaches in order to find a context for restructuring the way standard content is taught in order to infuse teaching for a particular skill. In the example above, the topic is the study of the eras of the development of the earth and the changes in the earth up to the present. This is standard material in elementary science programs. The key to the selection of the extinction of the dinosaurs as a context for infusion is that it is quite correctly identified as an issue of causal explanation. This topic recommends itself for a lot of reasons. It is an unsolved mystery, but also one about which people are presently thinking. Thinking about it does not require a great amount of technical sophistication in science, so it can be set into an elementary school context. Finally, it is a topic that rarely fails to intrigue even the most science-shy students. Thus it can also be a route to overcoming this negative attitude about science.

We are not suggesting that every reader of this book who teaches in the upper elementary grades should use this lesson. But we are sure that there are a number of equally rich content opportunities like these in the repertoire of each teacher to provide similar contexts for developing infused thinking skills lessons.

It is important to draw a contrast at this point. Teachers have, of course, taught about dinosaurs for a long time, and these creatures have captured the imagination of students since they started learning about them. Indeed, lots of good thinking has gone on in

school classrooms in connection with these topics—not merely recall and comprehension.

We applaud these efforts. We disagree with critics who give us the impression that teachers never stimulate good thinking in their classrooms. What goes on in such classrooms, however, may not be enough. In our experiences such teachers often create a stimulating classroom environment for thinking and help students build attitudes of openness and exploration. But in many cases this stops short of the specific type of directed thinking skills instruction that the teachers whose works we have described in this chapter practice. The lesson on dinosaurs shows how many things that have been going on piecemeal in classrooms on this topic can be organized in conformity with a model of good thinking. This serves the purpose of learning important forms of thinking that have *not* been the specific goals of such instruction in the past. It is this that is new in what we are presenting.

Our purpose in this section has been to look carefully at the way the core activity in various thinking skills lessons is structured. These activities were created by teachers who have focused their teaching on the use of specific thinking skills and infused this instruction into the fabric of their standard subject area courses. We hope this provides guidance for other teachers who want to construct similar lessons.

Additional Components Of Infused Thinking Skills Lessons

Structuring core activities for *active* organized thinking in accordance with a thinking map is very important. It is not the only ingredient, however, that the teachers we have been discussing have incorporated into their lessons to make them good thinking skills lessons. There are at least two other factors that are present in these lessons that are equally important:

1. ways of helping students become *aware* of the thinking they are doing (metacognitive awareness); and
2. reinforcement of the lesson's thinking goals through continued varied practice in using the skill.

There is also the matter of the classroom environment in which these thinking skills lessons are conducted. This is usually set up to be conducive to more open discussion among students than we find in classrooms that have less of a thinking emphasis.

Let's look first in this section at the kind of teaching Kevin and Cathy do to stimulate metacognition.

Metacognitive awareness of thinking

A major goal in lessons like those designed by Kevin O'Reilly is the assimilation of new ways of thinking into the lives of his students. This means, for Kevin, that the students don't just do some good thinking in his classroom. Rather, they perform appropriate thinking tasks *reflectively*. They think *about* their own thinking as they move along in considering the reliability of the sources of information that are available about the Battle of Lexington. This gives students an opportunity to become aware of, monitor, and direct their own thinking. Much research indicates that metacognition, practiced as an integral part of thinking skills instruction, can have a dramatic impact on learning and using thinking skills.

In Kevin's and in Cathy's lessons, this is often promoted by the *identification* of the skills through the use of a *thinking skills vocabulary*. Cathy Skowron deliberately identifies what her students are doing in thinking through what might explain Chicken Little's bump on the head as *finding the cause*. Kevin requests that his students list factors that count for and against the *reliability of an eyewitness*. These are components of their lessons that promote varying degrees of students' awareness of what they are doing in thinking. There are no hard and fast rules about where teachers should do this: before, during, and after the central activity are all equally viable.

This is only one way in which these teachers try to enhance the students' awareness of their thinking. In chapter 3 we described four gradations in the way people may use thinking skills: from the tacit use of these skills to a full-bodied reflective use. Three of these—stimulating *aware* uses, *strategic* uses, and full-blown *reflective* uses of these skills—involve levels of metacognition. It is easy to identify what we have just described as a set of techniques that will stimulate an *aware* use of these skills by the students, insofar as they come to identify what they are doing by using a thinking-skill vocabulary. This is important in teaching thinking. But more important is the need to help students move beyond this and engage in both strategic and reflective uses of these skills. Kevin and Cathy both engage in teaching strategies directed at these goals as well.

For example, Kevin sometimes lists factors he would like his students to take account of in thinking about the reliability of eyewitnesses. Here he is giving them a *strategy to follow* in their thinking. Cathy helps her students recognize that they are thinking about *possible causes* first, and then looking for *evidence* about which is the real cause. She is also giving them a strategy.

On other occasions Kevin sets his students in a more discovery oriented mode and asks them to list the factors they did uncover that counted in favor of and against the reliability of the eyewitnesses, and then to develop a set of principles or guidelines that they can follow in other cases in which the reliability of eyewitnesses is an issue. Here he is trying to help them engage in a *reflective* use of this skill: they are trying to figure out an effective set of guidelines to use in doing this sort of thinking, and then they will direct their own thinking accordingly when they next face this issue.

We will expand on the various techniques that have been used for promoting these three levels of metacognitive awareness in teaching thinking when we get to chapter 7. It is enough for readers at this point to see some of the techniques that the teachers on

whom we are commenting use to build this crucial feature into the way they teach specific thinking skills to their students.

Extended practice for transfer

A final feature of these lessons involves students in *varied practice in applying* the skills to other appropriate situations. These include both academically oriented examples and extra-classroom situations in school or in daily life. For example, when Kevin moves on in his classroom to study slavery, the students read various eyewitness accounts of conditions in the South prior to the Civil War. Are these reliable accounts? Kevin here asks his students to use in a new context the skill that he has introduced in connection with the Battle of Lexington.

In chapter 7 we will discuss the kinds of varied examples teachers can introduce into their teaching as follow-up activities. These serve to maximize their effectiveness in teaching specific thinking skills. But the importance of *varied* practice as an enhancement technique in teaching thinking is something we cannot stress enough. Repeated practice with the same sort of thinking will help to reinforce students' learning of these skills and promote their transfer to other situations. In this respect learning a thinking skill is not unlike learning other skills: one try, however successful, is usually not enough for complete learning.

But more can be said about the character of varied practice as a technique to reinforce the use of the kind of thinking you may want to teach students. *Reflective and deliberate* practice based on a blending of a metacognitive awareness of the appropriate forms of thinking to be used and reflection on new and varied examples is well-researched as an extremely effective classroom strategy in teaching thinking. We have described how Kevin promotes this in his classroom in our discussion of the ways that he introduces metacognitive reflection into his teaching. We will describe others in chapter 7. Our point here, though, is that just as teachers should be sensitive to how they introduce metacognition into their teaching to make it most effective in enhancing the learning of good thinking, they should also be sensitive to the

way they help their students to use the skill repeatedly as a follow up to the initial activity in the lesson.

To summarize the previous two sections, there are three basic features of thinking skills lessons that are present in varying degrees in much of what teachers are now doing in teaching for these skills (Table 4.4).

Table 4.4. Three Basic Features Of Thinking Skills Lessons

1. The active structured use of thinking skills;
2. Creating an awareness of the thinking that students are doing;
3. Varied reflective practice in applying the skill.

These are features that are distinctive in the present movement to bring skill-oriented teaching for thinking into the classroom. They mark such teaching off from many previous practices—however successful—designed to stimulate student thinking.

To practice these strategies well, teachers must know which questions to raise, and then how to direct the activities further so that students will use and reflect on particular thinking skills. This should grow out of an understanding of the kind of thinking the classroom activities are deliberately structured to promote. Exactly *how* this is done in the classroom, on the other hand, is a function of factors that can vary from classroom to classroom: the age and general abilities of the students that are taught; the individual teaching styles of the teachers involved; and even the length of class periods. Integrating these features of teaching thinking into

your classroom in exciting ways is indeed part of the artistry of good teaching. While we stress some general guidelines in this book that should be followed in any attempt at teaching thinking, teachers should be aware that there are no pat formulas for success as there are likewise none for good teaching in general.

Infusing Thinking Skills across the Curriculum

Attempts to infuse teaching for thinking into regular subject area instruction have yielded a diversity of classroom activities. Their variation is a function of content, grade level, pacing, and the thinking skills involved. In this section we highlight issues about infusing thinking skill instruction *across* the curriculum.

We indicated in chapter 1 that there is good reason to think that students are never too young to exercise the skills of good thinking with grade-appropriate content. The work of teachers like Cathy Skowron bears this out. The potential for infusing teaching thinking, then, clearly cuts across K-12 instruction as well as the different subject-areas of instruction. It is even a technique for curricular change that can be used at the college and university level. We wish to mention a few other examples which show how broad the opportunities for such infusion are in the curriculum that already exists in most schools and school systems.

A high school English teacher has reorganized the way she teaches the play *Romeo and Juliet* for eleventh and twelfth graders. Previously, she taught this play for dramatic structure, character development, and vocabulary building. Now she incorporates activities that also aim at some of the critical thinking skills we mentioned earlier. She has her students focus their thinking on the *causes* of the tragedy, and the issue of whether anyone was responsible. The activities her students engage in are upper-grade analogues of some of the thinking activities Cathy Skowron introduces her students to when they think about what could have caused Chicken Little to receive the bump on her head.

Similar lessons that focus students on strategies and skills used in thinking through a causal explanation have been developed on endangered species in high school biology; on the sub-

tleties of weather prediction in elementary science; on the motivation of characters in short stories in language arts and English classes; and on the causes of major events in American history. A high school shop teacher has even developed lessons using the same conception of causal inference to help students think through different methods to prevent kickback on table saws.

Moving from individual classrooms to a broader school-wide perspective creates an opportunity for coordination *between* teachers in the same school or school system. This can have an impact on student learning insofar as the same sort of thinking is reinforced across the curriculum, and what is taught at one grade level is consonant with what is taught at another. Even just using the same thinking terminology from subject area to subject area can be important.

We indicated in chapter 3 that a general conception of good thinking, which incorporates a core of thinking skills, activities, and dispositions that cut across different subject areas could be developed. This holds true even though idiosyncratic thinking skills and activities may be stressed in one subject area more than in others, or even exclusively in one. Hence, we endorse the idea that groups of teachers working together (or schools/school systems/school districts) should attempt to embrace a common conception of good thinking and its components. This can then serve as an instructional basis for organizing a coordinated program of thinking skill activities across the curriculum. We therefore wish to endorse the following principle related to infusion as an approach to bringing teaching for thinking into the classroom as part of an across-the-curriculum effort:

> Goals in teaching thinking should be based as much as possible on a general conception of good thinking that cuts across the traditional academic subjects.

Concluding Comments about Infusion

What the examples we have considered in this chapter show is that there is enormous potential already in the curriculum for raw material with which to structure exciting thinking skills lessons. In this chapter we've tried to dissect some state-of-the art examples of such lessons to show how teachers can construct them. The needed expertise is something, we believe, every teacher can develop. While this is not something that can be accomplished overnight, it does not take decades either. It must, however, be rooted in what we already know—and what works—in the field today. Thus we want to encourage teachers who develop good infused lessons to share these with others in their subject areas, help them to understand the features of the lessons that make them into good thinking skills lessons, and engage in an open and constructive exchange of ideas about ways of designing such lessons. This will communicate what infusing teaching thinking into subject area instruction involves in a manner parallel to that which we hope we have conveyed to readers of this chapter.

Schools that undertake infusion projects have a great potential to transform the way their students think. Reinforcement of good thinking across the curriculum builds a powerful force for learning into the fabric of the students' everyday educational experience. But some schools cannot— or cannot yet—undertake such projects. In the next chapter we turn to what many view as an alternative approach to bringing teaching for thinking into a school: the use of a special program or course designed to be incorporated as a *separate* component into the school curriculum. Although this approach typically has its limitations in separating teaching thinking from the main instruction that takes place in a school, it recommends itself as a way of moving thinking oriented instruction into a school more rapidly than infusion projects can be implemented. Thus, while we recommend that schools consider seriously the potential for learning good thinking along with traditional content in the separate subject areas that infusion provides, we also want to recommend a good look at the virtues of

using one or more of the separate programs that are available for teaching thinking. The subject of the next chapter is what to look for in such a separate program.

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CHAPTER FIVE

CHOOSING AND USING SEPARATE INSTRUCTIONAL PROGRAMS DESIGNED TO TEACH THINKING

In many ways the idea of teaching thinking through a separate program comes naturally to any educator. After all, what more powerful vehicle exists for a sustained and systematic learning experience than a special course or a self-contained and well-designed educational program? We teach distinct subjects, such as biology, this way, as we do more specialized subjects, such as American history. Similarly, we undertake skill-oriented instruction in important areas like reading, mathematics, and writing, using the separate course or program as a vehicle. Surely, thinking is an important basic skill area for which the separate program, using its own textual material and constructed of one or more special modules or courses, also seems especially suited.

Indeed, such has been the thinking of a number of curriculum developers, teachers, and university faculty. The products of their efforts range from commercially available programs with both student and teacher materials to single courses designed by individual teachers, offered on specialized forms of thinking, such as critical thinking. These all share the same feature of being constructed as *separate and self-contained components* of the curriculum whose primary goal is to teach good thinking—either in its entirety or in some specialized form.

A contrast exists between this way of fitting the teaching of thinking into a curriculum and the way we have just described—infusion. While the former is marked by *adding* a separate unit in the form of courses and programs of study *onto* what is already there in the curriculum, infusion involves integrating and *blending*

a new component *into* what is already there by restructuring the way the existing educational goals are met. The analogy between this and contrasting approaches with regard to teaching writing in the educational world today—teaching writing through a separate writing course or teaching it across the curriculum and blended into it—is an obvious one that will come to many readers' minds.

We wish to explore some of the features of separate programmatic approaches to teaching thinking in this chapter. We do this to help those considering such approaches—or already using them—make wise choices about which to adopt, their design, and how they are to be used.

Features of Stand-alone Programs That Teach Thinking

Typically, stand-alone programs designed to teach thinking have a number of characteristic features:

- the primary goal of the program is instruction in thinking of one type or another;
- the type(s) of thinking are taught in an organized and systematic way;
- learning the content material used to illustrate the type of thinking taught or used in exercises for practice is not an instructional goal of the program. This material is presumed to be known already;
- a variety of different content material is used throughout the program; and
- the integration of the program into the regular curriculum of a school or college requires a separate time outside of and in addition to the standard subjects taught.

We used the word "typically" here because there are variations on the typical case in which one or the other of these features is modified. For example, some programs make use of more consistent content material in illustrations and exercises, e.g., in solving a particular mystery. And others have modules that can be

split off and taught as additional mini-units within regular courses. But these five characteristics hold true for most of the self-contained programs and courses that presently exist for teaching thinking.

The closest thing to a general characteristic of all such programs is their "stand-alone" nature; i.e., time must be set aside for them, either as whole integrated units or courses or as more fragmented modules. This time is additional to that in which students are involved in language arts, English, science, mathematics, and history. In the typical case, a block of time, usually a regular "period" in a school or college, is set aside for the program.

Many such stand-alone programs are not home-spun like the infusion projects described in chapter 4. Rather, they are designed by curriculum writers other than the teachers who use these materials. We do not, however, include this as a basic characteristic of such programs. This is not simply because there is a wide variety of exceptions (as in the case of college courses designed by a faculty member who teaches them). Rather, it is because it seems merely incidental that such programs are designed by curriculum developers who are not regular classroom teachers. Nothing essential about these programs would change if it were classroom teachers who designed them and disseminated them to others in their profession.

Still, the fact that most of these programs are, as a matter of fact, designed by curriculum developers who are not their primary users has important implications for how easily individual teachers can use such prepackaged programs. This will be discussed in chapter 8. There we will indicate that this issue is a general one that teachers face when they use certain programs and materials available now that also infuse teaching thinking into standard subject-area instruction. There are indeed some commercially available infused programs which include sets of curriculum materials designed by curriculum specialists who are not the standard users of the programs.

Adopting a stand-alone program and infusing teaching for thinking into the standard curriculum are obviously not mutually exclusive approaches. A school may incorporate both. In fact, we favor a version of such combined approaches, where this is possible, so long as one component complements and reinforces the other. There are, of course, many ways that this can be accomplished. For example, an emphasis on teaching thinking can be infused throughout the standard curriculum. This could be based on the models promoted in some particular stand-alone program that is the pivotal point around which teaching thinking occurs in the school. This is sometimes called "bridging." Or—going in the other direction—a separate course might be spawned by a coordinated across-the-curriculum infusion effort. This could serve to help students stand back and reflect on the way the same basic forms of thinking play themselves out in the contexts of different fields of study. It could help them determine whether there are idiosyncratic forms of thinking that are tied to certain fields, how standards of rigor vary, and how common patterns of ineffective thinking may break out in different fields and how they can be identified and corrected, etc.

There are obviously many other variations on this theme. But we wish to stress that coordination of teaching and reinforcement of good thinking should guide the design of such combined efforts. There is nothing more confusing to students in learning to think than promoting certain ways of thinking in a stand-alone program which are ignored and replaced by other ways in regular subject-area instructions.

The Role of Content in Stand-alone Programs

Here is part of a lesson from a student booklet that is contained in a typical stand-alone program for elementary school students that has as its goal teaching specific thinking skills (Black and Black, 1987):

Parts of a Whole—Select

Read the four words listed for each exercise and decide which one represents a whole thing, as opposed to parts of the whole (represented by the other three words). Write the word that represents the whole on the line provided, then list the words that make up its parts.

C–5 hem, jacket, lapel, seam
WHOLE _____ PARTS _____, _____, _____

C–6 cuff, inseam, pants, waist-band
WHOLE _____ PARTS _____, _____, _____

C–7 core, fruit, peel, pulp
WHOLE _____ PARTS _____, _____, _____

C–8 heel, shank, shoe, sole
WHOLE _____ PARTS _____, _____, _____

C–9 bicycle, chain, fork, frame
WHOLE _____ PARTS _____, _____, _____

C–10 clasp, coil, safety pin, shafts
WHOLE _____ PARTS _____, _____, _____

This lesson is one among many designed to help students with skills of classification. In this case, these skills require certain analytical abilities on the basis of which students break a "whole" into "parts"—each of which is identified verbally—and then classify these items as wholes or parts.

On the next page is another example in which the same core analytical skills of dividing up a whole into parts are involved (Feuerstein, 1981). Once again, learning this skill is the main goal of the lesson. In this case, figures (rather than words and concepts) provide the content that students are asked to think about using this skill.

Look at the figure reproduced below. For each drawing in the left column, there is a drawing in the right column which completes it. Write the number and the letter of the two drawings you combine to make a complete figure.

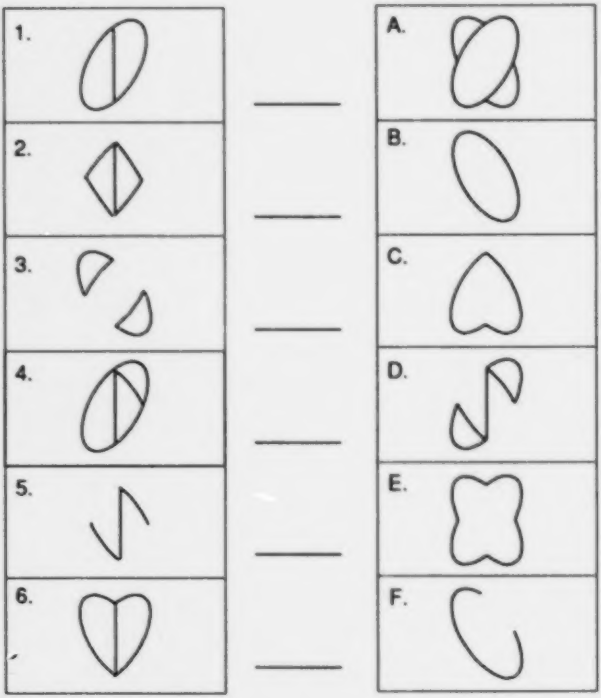


Figure 5.1. Example Involving the Analytical Skills of Dividing a Whole into Parts

(Feuerstein, *et al.*, 1979, reprinted by permission of Curriculum Development Associates)

These examples typify what appears in a whole range of stand-alone programs. They are designed to give students practice in using specific forms of thinking, and they are integrated into a program that progressively moves from one such form of thinking to another, using similar exercises for practice. There are usually a number of exercises provided on the same skill, and they often become progressively more complex and challenging. The goal of such programs is the mastery of the skills involved in performing these types of thinking.

There are, of course, a multitude of questions for which any practitioner will want to seek answers to decide whether and how to use such programs. These questions fall into three categories:

(1) What *kind of thinking* does the program aim to develop and what *content material* are students given *to think about* in practicing this kind of thinking?

(2) What are the *instructional strategies* employed in teaching this kind of thinking?

(3) What *support systems* does the program provide to enable teachers to use it with facility?

These are questions to which, in fact, practitioners will want to seek answers in designing and making choices about infusion projects as well. Our intention is to spend the next three chapters illustrating what one should look for and what one will find when trying to answer these questions, no matter what type of approach—stand-alone or infused—we are considering. In this chapter, however, we intend to make some comments specifically about stand-alone programs and the first of these questions. We are concentrating on this here because of the particular way the kinds of thinking taught in stand-alone programs are treated in relationship to the content used in these programs. It is here that we find some quite distinctive features that are not typically found in infusion projects.

The examples cited above represent two variations on a common theme connected with what students are asked to think about

in working through the material in many stand-alone programs. The content employed in the examples is material with which we presume students are already familiar. The variation represents a difference of degree. In the second example, the presuppositions required for content-familiarity are deliberately minimized. Familiarity with shapes is all that is necessary to understand and complete the thinking task. In the first example, some verbal skills, as well as familiarity with the kinds of things being discussed, are presupposed.

Lessons like these are in certain important respects *content-indifferent*. By this we mean that the content could vary widely and the lesson would still have the same educational objective: to teach to the particular form of thinking in question. There are only two constraints that are usually imposed in choosing content for the exercises in these programs: (1) that what the students are asked to think about be something about which they already have knowledge, and (2) that it be simple and noncontroversial enough so it does not distract from the thinking activities that serve as the core of the lesson. The two examples cited above, therefore, illustrate different degrees of operating within these constraints.

The idea of content-indifference has another dimension. It is typically the case that students are given a multitude of exercises like these with which they practice the skills. The content used in different examples often varies considerably and usually bears little or no important relationship to other subject-matter that students think about throughout the program. Usually it doesn't matter what content is used in any two consecutive exercises.

There is a great deal of flexibility in stand-alone programs for choosing content for the lesson activities. This contrasts with infusion projects, in which the lessons that are designed to teach thinking are created within the framework of the content material taught in standard subject-area instruction, such as American history or elementary mathematics. It is, of course, not possible to design a program to teach thinking in which there are activities to give students practice in good thinking that are entirely devoid of

content. When we think, we must think about something. But, as we mentioned above, the content of a thinking skill lesson may be incidental and merely a vehicle for helping students to learn the forms of thinking taught. This is the case in most stand-alone thinking-oriented programs.

The result is that there can be—indeed there is—great variability even within a particular program in what students are asked to think about in learning the forms of thinking that are the goals of the program. A whole array of real life and academic examples that curriculum designers can draw from are available. But there is one thing about which you can be quite sure in considering typical stand-along programs: not much new content knowledge will be acquired by students who work through such programs.

Many texts used in higher education in stand-alone logic, informal logic, and critical thinking courses have this same feature. While their authors may strive for examples that they feel will be more interesting and complex for college students than the examples cited above, the examples used in these textbooks generally are chosen on the basis of the same criteria. In the same sense, the instructional goals of the courses in which such texts are used are also content-indifferent.

We mentioned initially that such programs form a large class of stand-alone programs. But there are exceptions. In some cases there is a deliberate effort to use "real life" examples for students to think about, and in others there is even a coherence *throughout* the program in the content used to illustrate and provide examples for practice. Here is a representative example of a lesson designed to teach a critical thinking skill. This is the same skill used in the lesson on the Battle of Lexington—that of distinguishing reliable from unreliable sources of information—using a "real life" example. This lesson is part of a series of thinking skill lessons in a program on critical thinking (Winocur, 1983):

"Who Knows?"

Study Sheet 1

Directions: There has been a serious plane crash in which a light place clipped the right wing of a jumbo jet. A government Commission has been set up to investigate the accident. As a clerk for the committee, it is your job to sift through a list of those who wish to appear before the committee to give evidence, and decide which ones should be called to give reliable data to the Commission.

I am going to give you a list of witnesses and the location of the witnesses at the time of the accident. I would like you to circle the names of those sources whom you believe could supply the most reliable data. Beside each name on the list, give reasons why you chose or did not choose that person.

List of Sources

1. Captain of the jet's flight crew
2. Pilot of the small plane (bailed out prior to impact)
3. Steward on jet (was in the galley preparing food during impact)
4. Passenger No. 1 (was sitting on the left front side of jet)
5. Passenger No. 2 (was sitting over the left wing)
6. Air Traffic Controller
7. Airline Official in the terminal
8. Manufacturer of light plane
9. Widow of man who was killed in the crash
10. Representative of the aircraft insurance company
11. F.C.C. official who inspected both air crafts after the crash
12. Pathologist who performed autopsy on dead passenger
13. Farmer who was ploughing his field below the site of the crash
14. Steward (in the cockpit at the time of the crash)
15. Film crew from a local TV crew who shot film of the crash from their helicopter

(Winocur, reprinted by permission of Orange County School District, Costa Mesa, CA.)

In this lesson one can even detect a loosening of the constraint against including informational content with which students are unfamiliar in such exercises. One would not want to do this lesson with students in kindergarten. But certain students in the upper elementary grades who do know something about commercial airline flights may not only be able to work through this lesson with ease but may also learn some things that they didn't already know (e.g., the jobs of stewards on commercial aircraft). Such lessons can still appear as part of a series of similar lessons in an integrated program for thinking skills instruction that functions as a separate stand-alone component in the curriculum.

To whatever extent content used in individual lessons like these may or may not be familiar to students, we nonetheless do find a wide variation *among* examples used throughout many stand-alone programs in which such lessons are found. Troubled by this, some curriculum developers have tried to minimize this variation. There is nothing to prevent a curriculum designer from using a fictitious story of a crime set up as a detective story to prompt students to gain practice in using—and hopefully learning—a variety of thinking skills and activities as they work through the story. Indeed, some free-standing programs available today incorporate just such a feature in their design. This in no way compromises their primary purpose in teaching various forms of thinking systematically as the goal of the program.

With all this said, we do wish to point out that there are commercially available programs, as well as special courses that teachers have created to teach thinking, that *do* also aim at helping students learn about the various topics and issues that serve as the material they think about in the program or course. For example, social issues like the arms race, the prison system, population problems, and the role of the elderly in society provide a content focus in a whole cluster of stand-alone programs presently available. These fall into a grey area between stand-alone programs and infused approaches. On the one hand, they are usually

brought to students as electives, or are used as supplementary modules within a social studies program; therefore, they are still taught *apart from* standard instruction in regular subject areas. Yet, as individual programs, they often incorporate many of the techniques of infused projects; e.g., the way the content is taught is bound up in the thinking activities that are structured into the program. For our purposes, such programs will be considered special cases of infused efforts, rather than stand-alone programs to teach thinking.

What can we say about these variations in approach to the use of content in stand-alone thinking programs? There is no indication that the teaching of thinking can *only* be accomplished—or even can most effectively be accomplished in general—when content is minimized, as it is above in the second example, or when it is kept a simple task, as it is in the first example. In fact, in many cases the more interesting the content and the more challenging the exercises, the more likely it is that the students will sustain the thinking tasks they are given. And there is no clear evidence that average students do get distracted from the thinking tasks even when there are additional things that they learn (e.g., when they think about matters like the plane crash above). But of course one would not want to use a program which drew upon examples and topics for thinking tasks that were well beyond the knowledge and/or experience of the student. There *is* evidence that *general* ignorance about what is being thought about does inhibit good thinking.

We should be cautious, however, about drawing too much from these remarks.

It may be very effective to teach skills in certain classroom situations by beginning with content-sparse exercises (as in the second example). Subsequently, exercises that are richer and more interesting in content may be taught. Similarly, introducing students to a skill using *simple* tasks like those given in the first example, *followed by* more complex tasks, may well be an equally effective way of teaching the skill. With such a progres-

sion of activities, none of the problems about the exercises being boring or the students becoming distracted by the content that we have noted need necessarily matter. And indeed, many thinking programs do include such progressions. On the other hand, if these types of examples are *all there are* in a program, we perhaps should be concerned, just as we should be if the examples all involved content that was technical in nature and that the audience of students did not grasp.

But even here there may be exceptions. There may indeed be *special* cases in which distractability from a thinking task or attention span is a factor for some students. Then one may want to choose programmatic material in which the content is not especially rich or complex. In fact, some programs are constructed specifically for students with various special needs and quite deliberately are sparse on content for this very reason. Obviously the choice of a particular programmatic approach, all other things being equal, will have to be determined by a sense of who the students are who will be using the program, and how they, in general, best react, given these variations in the role of content.

With this in mind, we may summarize our discussion of the role of content in the illustrations and exercises included in many stand-alone programs by noting two questions that must be asked:

(1) How familiar are your students with the informational content that they are asked to think about in performing the thinking tasks in the program?

(2) How interesting to your students are the things that they are asked to think about?

We are well aware that there may be clear trade-offs here: the more familiar, the less interesting some things may be. As always, wise choices of already existing programs or of ways to design new courses on thinking must take into account answers to relevant questions. These questions might concern the program and accurate information about the capabilities and needs of the students being taught. In some contexts, familiarity may be the overriding factor; in others, interest.

The Kind of Thinking Taught in Stand-alone Programs

There is wide variability as well in the kind of thinking taught in stand-alone programs, even though the same surface terminology is used by their publishers to describe their goals. Hidden behind claims that a program teaches thinking skills, for example, may be a more accurate reality that is revealed when we look deeper and find that only a certain range or type of thinking skills are taught in the program, e.g., critical thinking skills.

In general, we would urge caution in thinking that any one program or course of study teaches all of the different kinds of thinking it is important to help students learn. The framework we have set forth in chapter 3 provides us with a way to locate the thinking goals of a program within the range of the kinds of thinking that it is important to teach.

In addition to emphasizing different *kinds* of thinking (e.g. critical thinking or creative thinking), many programs also emphasize different *aspects* of thinking. The following breakdown is intended to capture three common types of programmatic goals which emphasize different aspects of students's thinking which program designers feel need improvement. These, in fact, coincide with three aspects of thinking that we flagged as improvable in Chapter Two (see Table 2.1) They are:

- Improve attitudes that impel and direct good thinking, like being openminded, being motivated to seek reasons for claims, etc.
- Improve various *organizational patterns of broad think ing activities* like problem-solving and decision-making.
- Improve a variety of *sub-skills* used in the way we retain and represent information, in creative thought, and/or in making critical judgments.

The first of these promotes a "spirit" of good thinking, usually through open discussion of various issues. The second typically concentrates on broad patterns of thinking, like considering what your options are first in trying to make a well-thought-out decision,

then making a systematic pro/con list that helps sort out which options are best. Usually students are helped to develop habits of such organized thinking through a lot of decision-making and problem-solving activities. The third emphasis is typified by a more atomistic approach in which a lot of different, sometimes very specific thinking skills are isolated and taught, using acitivities like the three we have reproduced earlier in this chapter.

These are by no means imcompatible emphases that you must choose between. Treating them as such is one of the hazards we noted in chapter 2. The remedy for this is to look for all three emphases. If you can find them all in one program, all the better. If not, this may mean chooosing a number of different programs, or supplementing some that are already used with activities of your own making for students that emphasize what the program in use does not.

A problem for the practitioner in making such judgments is that some programs not only emphasize specific kinds of thinking from only one or two of the categories we mention in chapter 3, but also emphasize only certain aspects of thinking like those just listed within one of these categories, de-emphasizing others. For example, a program may emphasize problem-solving. It would help students to use some general organizing strategies for solving problems, such as moving from a clarification of the problem to the generation of a variety of possible solutions. Then it would move on to a choice of the best solution from among these options. Such a program may spend a good deal of time on activities related to the *creative* generation of original solutions to problems, stressing fluency and flexibility of thought in generating ideas, and using brainstorming as a technique. But it may give only cursory attention to the *critical* thinking skills needed to assess which solution is the best. It may, for example, simply ask students to choose the best option and give reasons for their choices, rather than spend much time in any detailed examination of the strengths and weaknesses of each option. It will be important for a practitioner who finds aspects of such a program compelling to recognize its scope and limits by noting what is included and what is left out of its design.

In getting a sense of which important kinds of thinking are emphasized in a program and which are not, it may be helpful for practitioners to have a map of the domain of thinking which locates these various ingredients in relation to each other. While any such map is bound to be schematic, here is one based on our discussion in chapter 3.

When you use this map, we suggest that you ask the following questions:

- What forms of thinking that appear on this map are emphasized in the program under consideration?
- In cases in which a form of thinking is not emphasized, what can be done to teach this as well?

Answers to these questions necessitate a deeper look at what specific stand-alone programs teach than their titles or short blurbs furnished by their publishers provide.

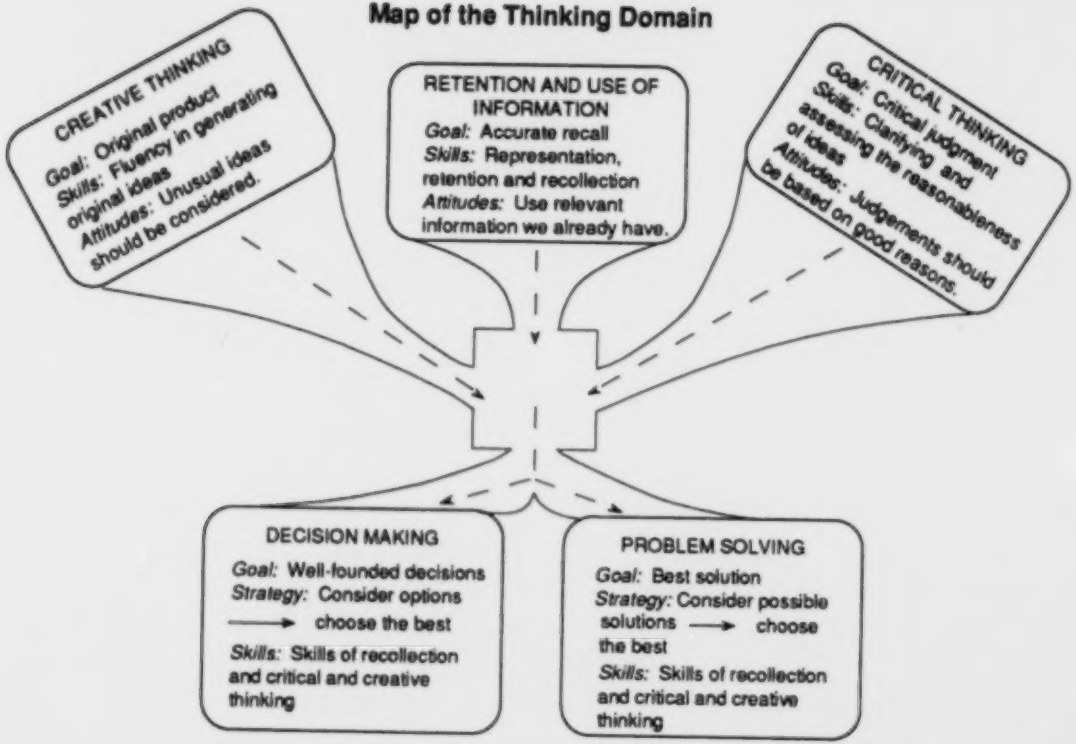
Critical Thinking Courses

A special case of the approach to teaching thinking we are considering in this chapter is the separate course on critical thinking. The prevalence of this as a vehicle for teaching thinking—especially in college and university settings—warrants a special look at it. Here we wish to communicate to interested readers a variety of ways that such courses have been structured and how each fits into the overall enterprise of teaching good thinking.

>> *Goals of critical thinking courses*

We commented in chapter 3 that some people use "critical thinking" in a broad way to cover *any* sort of thinking. We are using this term in a more circumscribed—and we feel more ordinary—way in this book. Critical thinking is *one way* that thinking occurs. It is a way of thinking that is of tremendous value to us in learning about ourselves and the world, in using our knowledge to make wise choices, and in communicating with others. Most educators recognize the importance of critical thinking and many have made it an explicit agenda in their teaching and in the goals of the educational institutions with which they are affiliated.

Map of the Thinking Domain


CREATIVE THINKING
Goal: Original product
Skills: Fluency in generating original ideas
Attitudes: Unusual ideas should be considered.
RETENTION AND USE OF INFORMATION
Goal: Accurate recall
Skills: Representation, retention and recollection
Attitudes: Use relevant information we already have.
CRITICAL THINKING
Goal: Critical judgment
Skills: Clarifying and assessing the reasonableness of ideas
Attitudes: Judgements should be based on good reasons.
DECISION MAKING
Goal: Well-founded decisions
Strategy: Consider options → choose the best
Skills: Skills of recollection and critical and creative thinking
PROBLEM SOLVING
Goal: Best solution
Strategy: Consider possible solutions → choose the best
Skills: Skills of recollection and critical and creative thinking

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In articulating this agenda and in defining these goals it is important to be clear about exactly what critical thinking is and what is not. The account we have given of critical thinking in chapter 3 notes certain special characteristics that mark it off from other forms of thinking. We feel that although critical thinking can be practiced in thinking about almost anything, and although it has many varieties, all of these, nonetheless, share common features as examples of critical thinking. In thinking critically we:

- aim at critical judgment about what to accept as reasonable and/or what to do;
- use standards that themselves are the results of critical reflection in making these judgments;
- employ various organized strategies of reasoning and argument in determining and applying these standards; and
- seek and gather reliable information to use as evidence or reasons in supporting these judgments.

The cash value of this for educators is in distinguishing the important *varieties* of critical thinking that are important to use in different but frequently occurring situations we face in our lives and professional work so that these can guide how we teach students. This is similar to what the biologist does when he or she distinguishes the different types of living things against the backdrop of a common definition of what all of these varieties must have to be classified as *living*. It is this further articulation of the important forms of critical thinking that usually serves as the basis for the organization of critical thinking courses. These are typically set out in various taxonomies that supplement definitions that are offered of critical thinking.

Our approach to types of thinking (e.g., critical thinking) in this book is two-tiered: important critical thinking *skills* can be distinguished, and these skills function in use together with skills of creative thinking and information retention and recall in organized ways when we engage in broad thinking *activities* like solving problems and making decisions. Various creative thinking skills and

strategies may be involved in making a decision or solving a problem; for example, in generating new and unusual options to consider in trying to decide the best thing to do. What makes these forms of thinking *critical* thinking is, however, that various appropriate skills of discrimination, such as determining the reliability of a source of information or the most likely consequence of a proposed course of action, are employed, and the overall goal is critical judgment. (As we have indicated, there is no conflict whatsoever in the outcome of problem solving and decision making being a creative product as well; for example, a new and original solution to a problem.)

The skills of critical thinking fall into two basic categories—skills at *clarifying* ideas and skills at *assessing the reasonableness* of ideas. Some of the core skills in these categories are mentioned in chapter 3.

>> *Types of critical thinking courses*

It is this articulation of critical thinking that we feel can provide a mini-map against which to locate the scope and limits of critical thinking courses. Such courses—and, in fact, textbooks that are designed for such courses—fall into two categories. The first takes assessing statements and arguments as its primary context for learning the skills of critical thought; the second takes *problem-solving and decision-making* as its locus. Strategies for making decisions and solving problems, as well as the development and use of creative thinking skills are sometimes emphasized in the latter along with critical thinking skills (including skills at assessing arguments). Hence, while there is some overlap between courses that fall into these two categories, the second usually deals with a broader array of skills and strategies than are necessary to simply assess the validity of arguments.

The vast majority of critical thinking courses taught in college settings today fall into the first category. Some high school versions of such courses have come to our attention as well, and there is textual material available for elementary and middle school variants of these.

While acknowledging the importance of assessing arguments and statements in critical thinking, we wish to point out that the conception of critical thinking as fundamentally a matter of *reaction* to arguments is a narrower conception than we embrace in this book. This conception of critical thinking does have its roots in some early literature in the field in which critical thinking is conceived as a matter of assessing arguments. But by and large it is at variance with the way many now conceive of critical thinking. That conception is a broader *proactive* conception which is reflected in the way we have tried to articulate this concept. Deciding what to believe or do is its fundamental locus, and while assessing arguments that people offer about what to accept or do certainly may be involved in this, so are other roles for critical thinking skills. As we have pointed out, the skills needed to compare and contrast the strengths and weaknesses of different options and to choose between them are also involved.

This should in no way degrade critical thinking courses that focus primarily on arguments. Having skill at determining *when evidence is strong enough* to support a hypothesis about what caused something, for example, is *crucial* in making a well-founded judgment of causal explanation. This is the kind of skill that critical thinking courses typically aim at teaching. It is a skill related to the *support* certain information provides for the likelihood of the truth of certain other claims. In the instances of lessons on causal explanation we have included in this book so far—those on the Chicken Little story, *Romeo and Juliet*, and the extinction of the dinosaurs—this skill is essential in making a well-founded judgment about the strength of evidence in support of a possible explanation. These kinds of convergent judgments are typically made at the later stages in the processes of thought taught in these lessons. Similar comments can be made about skills needed to judge the strength of evidence in making predictions, in generalization, and in using analogical reasoning, as well as the skills needed to determine whether certain information deductively supports various conclusions. Using these skills is only *part* of what we do when we think through problems like what caused the bump on Chicken Little's head, what caused the dinosaurs to become extinct, or what the causes of the tragedy of Romeo and Juliet were.

Similar comments can be made about the role of arguments in decision-making. They have their place, of course. It is usually to support choosing one or another option that we might be considering in trying to decide what to do. I might be trying to decide between two different cars that I am thinking of buying. In the course of this, the salesman for one company may produce a number of arguments to convince me that the car he sells is the best one to buy. In this case, I should think about whether these arguments are good ones, and part of that involves considering whether the information he bases his claims on is accurate and supports the conclusion he wishes me to accept. Here is a way of diagramming the place of argument assessment in this broader decision-making process.

Traditionally, an argument is structured as shown below:

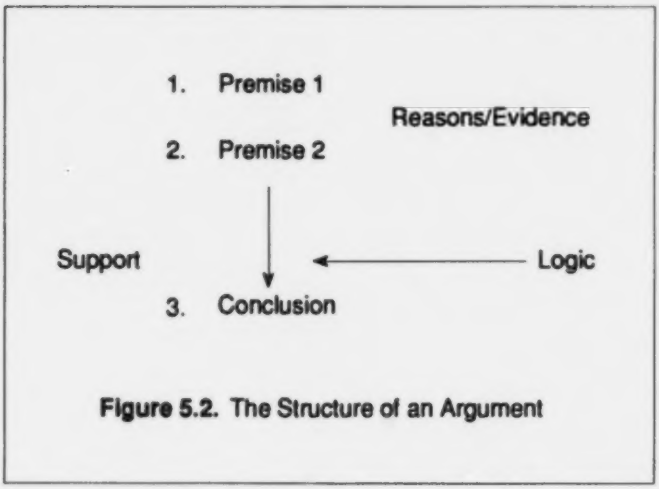

Figure 5.2. The Structure of an Argument

It fits into a broader decision-making framework in the manner depicted in Figure 5.3 on the next page.

This line of commentary illustrates how clarity about our overall goals in teaching critical thinking can lead us to locate the overall aims of *specific* critical thinking courses within a broad and well-articulated map of these goals. By doing this we not only realize the

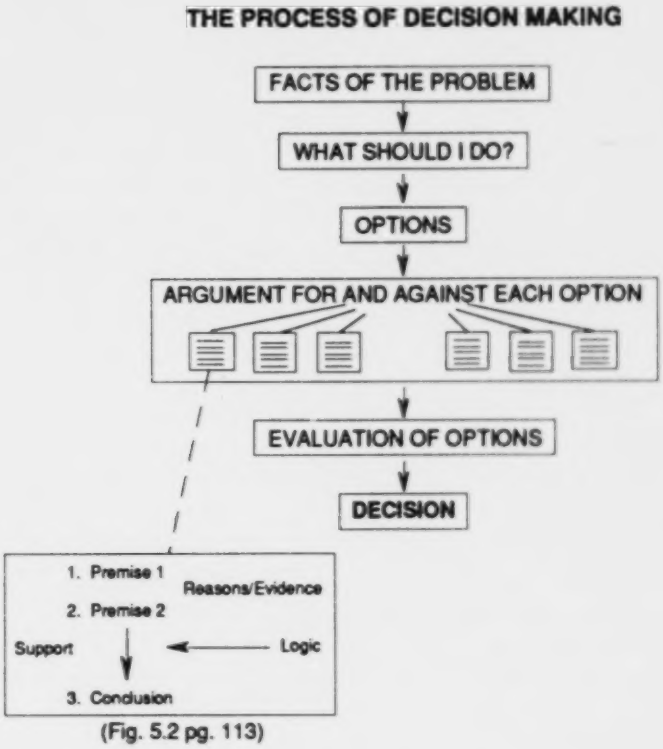

Figure 5.3. Arguments within the Decision-making Framework

scope and limits of such courses, but appreciate their value and strengths. We can recognize, for example, that critical thinking courses that stress skills at argument analysis and evaluation aim at skills that are valuable in problem solving and decision making, but that are by no means sufficient in engaging well in these broader processes. This can, in turn, help us in the design of these courses, or in the design of supplementary courses that aim at other things in doing good problem solving and decision making.

>> Formal and Informal logic courses

Critical thinking courses that focus on assessing arguments themselves fall into two groups. Many are, by and large, traditional *logic courses*. This first group represents a more traditional way of teaching skills at assessing arguments. These courses stress inductive and deductive logic as the primary skills to be used in assessing arguments. These skills often involve determining when a viable (valid) argument form or structure is displayed by an argument in the natural language of the person advancing the argument. Based on learning to tell whether such valid forms are present, students can make judgments about whether the information that the arguments start with—their premisses—is strong enough to support their conclusions and/or whether the conclusions are proved by the premisses (actually follow from the premisses by valid deduction). Students in these courses learn how to determine when such valid argument forms are present, and when they are not. It is characteristic of such courses that matters relating to whether the information that appears in the premisses of such arguments is itself acceptable—something that calls for critical judgment as much as the internal structure of the argument that the information appears in—is typically treated as beyond their scope.

In the second group, courses are set up as *informal* logic courses. They stress *nonformal* strategies at argument assessment, often turning on skills at detecting fallacies like the use of *ad hominem* arguments, and other common reasoning flaws. The idea in both types of courses is that learning these skills through practicing them with concrete examples can help us make wise critical judgments about whether or not to accept the conclusions of arguments, many of which are offered to convince us of things we do not yet accept.

We want to be clear that we have characterized this difference as a matter of stress or emphasis. In practice, there is much overlap between these two sorts of courses. While they may cover roughly the same topics, formal assessment of the validity of

arguments is stressed in some while in others assessing arguments that do not turn on formal features of reasoning is stressed.

Although as these courses play themselves out in the classroom, the difference between them may be just a matter of emphasis, this, in itself, is important. It reflects judgments made by teachers and textbook writers about which skills are the most important to teach to help students learn how to assess arguments.

To capture the flavor of this basic difference between these two ways of structuring courses that emphasize the assessment of arguments, we have listed in Table 5.1 (see next page), some typical topics that might be covered in each.

Texts for such courses are similarly arranged and characteristically use arguments as examples in the end-of-chapter exercises for students. Many instructors in these courses assign such exercises as homework to be graded as part of the work that students do in such courses. Here is a typical example from a text that is designed for the second type of course (Beardsly, 1975):

Exercise 13

Discuss the dependability of the following causal arguments. What weaknesses, if any, can you find? What important precautions may not have been taken? How could the arguments be strengthened?

7. Sixty blue collar workers in a Kansas pet-food plant have been participating in an experiment with potentially enormous implications: Instead of specializing in assembly line fashion, each gets a chance to shift around and do every major job in the processing plant, from unloading with a fork lift truck to making tests in the quality control laboratory. Each determines how to spend his time, free from supervision, and each is constantly learning new jobs or new aspects of jobs as he changes around. The workers are not bored, not alienated, not disaffected like so many American workers; the turnover rate is low and there are none of those random acts of spiteful sabotage that plague much American industry. Morale is excellent. This has been going on now for four months, and the conclusion is plain: rotation of jobs in this way significantly decreases worker boredom, and saves money, and it should be instituted everywhere.

Table 5.1. Typical Topics for Two Ways of Structuring Courses

Courses that Stress Inductive and Deductive Logic	*Courses that Stress Informal Logic*
The Nature of Argument	The Nature of Argument
Premisses and conclusion	Premisses and conclusion
Assumptions	Assumptions
Argument structure	Argument structure
Validity and soundness	Validity and soundness
Fallacies	Deduction and induction
Language	Language
Words and Ideas	Words and Ideas
Sentences and propositions	Sentences and propositions
Deductive Inference	Fallacies of Reasoning
Logical form and symbolic logic	Fallacies of language
Propositional logic: and, or, not, if...then	Equivocation, ambiguity
Quantificational logic: all, some, not	Fallacies of evidence
Traditional Syllogisms	Straw man, *ad hominem*, *post hoc*, bandwagon, etc.
Techniques for proving deductive validity	Formal fallacies
Venn diagrams, truth tables	Denying the antecedent, affirming the consequent
Inductive Inference	Types of Informal Arguments
Sampling and generalization	Political speeches
Cause and chance	Advertising
Scientific method	Moral arguments
Probability and statistics	

To prevent one from thinking that such courses and texts are designed only for college students, here is an equally challenging example from a critical thinking text that falls into the second category for middle/high school students (Harnadek, 1980):

> The constitution of the Student Council of Corbett High School includes the following:

Reasons deemed sufficient for removal from the Council shall include, but shall not be limited to, the following: . . . Conduct outside of school detrimental to the welfare of the Council of the School.

Joe Blake, a member of the Council, has been ticketed for the second time in six months for reckless driving, and some of the Council members tried to have him removed from the Council because of this. They used this argument in their petition:

As a member of the Council, Joe is considered both by students and by outsiders to be representative of the students of Corbett and to be held in generally high esteem by the Corbett students. When he willfully violates the law, as he has now done twice, he is creating a poor image of both the Council and the School. As a Council member, this poor image is then reflected upon all the Corbett students and, as such, is detrimental to the welfare of both the Council and the School.

Joe's reply was this:

As a Council member, I am considered to be a spokesman for the opinions of the Corbett students about school affairs, not to be representative of their attitudes toward life in general. The Council will continue to operate, and the School will continue to operate, regardless of whether or not I get tickets for reckless driving. And, since both will continue to operate regardless of any tickets I get, my getting the tickets cannot be detrimental to either the Council or the School.

(1) In your own words, what arguments did the students use in their petition to have Joe removed from the Council?

(2) In your own words, what arguments did Joe use in his reply to the petition?

(3) Refute as many of the students' arguments (in the petition) as you can.

(4) Refute as many of Joe's arguments as you can.

(5) What do you think? Should Joe have been dropped from the Council, or not? How come?

>> *Critical thinking courses that emphasize problem solving and decision making*

In contrast, critical thinking courses structured to reflect the more *proactive* conception of critical thinking that we employ in this book typically cover the following topics:

Courses That Stress Problem Solving and Decision Making

What is critical thinking and how do we get better at it?
- Critical thinking attitudes
- Critical thinking skills

Problem solving
- Problem definition
- Solution finding
- Everyday problem solving

Decision making
- Goals, options, and consequences
- Decision-making under uncertainty
- Values and choice

Getting information
- Reliable sources
- Concepts and meaning
- Recall and use of information

The nature of argument
- Premisses and conclusions
- Assumptions
- Argument structure

Induction and the use of evidence
- Sampling and generalization
- Cause and chance
- Scientific method and testing hypotheses
- Probability and statistics
- Fallacies in the use of evidence

Deduction
- Logical form
- Propositional logic
- Syllogisms

Language, communication, and understanding
- Words and ideas
- Sentences and propositions
- Written and oral communication

And here is a typical exercise for students from a text for such a course: (E. Neimark, 1987)

> Find in the newspaper some account of a recent decision made by someone in authority, for example, retaliation to an act of terrorism, the jury verdict in a trial, a change in existing law for the minimum drinking age, and reconstruct a decision analysis that might have led to it (that is, apply one of the decision methods described in this chapter). Was it a good decision or, in light of your analysis, are there better alternatives that should have been selected? What decision criterion appears to have been applied in this case?

>> *Other courses that stress critical thinking*

Typically, each of these types of critical thinking courses use a multiplicity of exercises with no constant content theme, and, in general, rely on the same principles of *content familiarity* and *interest* as a basis for selecting such examples that many of the more general programs designed for teaching thinking do. There are some courses, however, that are called critical thinking courses that revolve around more constant content themes. As we saw with stand-alone programs in general, these usually fall into the grey area between stand-alone courses and those that infuse teaching for critical thinking into disciplinary instruction. In some cases, teaching for critical thinking is typically infused into a more or less specialized content emphasis that falls within one of the standard disciplinary areas of instruction. In other cases, interdisciplinary courses—for example, in the humanities—provide the context for such instruction.

One such course that exemplifies taking a specialized topic within a traditional field of study begins with the following quotation from Harry Truman, as recorded by his biographer, William Hillman (1952, reprinted by permission of Farrar, Strauss, and Giroux):

> "We were planning an invasion of Japan with the use of 2,000,000 men and the military had estimated the invasion might result in very heavy casualties. In April I had appointed an interim committee to make recommendations on questions of policy when and if an atomic bomb could be made. The

> Committee consisted of Secretary Stimson, George L. Harrison, James H. Byrnes, William L. Clayton, Dr. Vannevar Bush, Dr. Karl T. Compton, and Dr. James B. Conant. Before I had left for Potsdam the committee had recommended that the bomb be used against Japan.
>
> "General Marshall said in Potsdam that if the bomb worked we would save a quarter of a million American lives and probably save millions of Japanese.
>
> "I gave careful thought to what my advisers had counseled. I wanted to weigh all the possibilities and implications. Here was the most powerful weapon of destruction ever devised and perhaps it was more than that. . .
>
> "I then agreed to the use of the atomic bomb if Japan did not yield.
>
> "I had reached a decision after long and careful thought. It was not an easy decision to make. I did not like the weapon. But I had no qualms if in the long run millions of lives could be saved.
>
> "The rest is history."

As students think through the question of whether Harry Truman's decision was a wise one, they learn various decision-making strategies and the use of a variety of critical thinking skills, many of which are covered in more traditional critical thinking courses as described above. They also learn a great deal that they didn't know before about the end of the second world war and nuclear weapons.

Courses that are interdisciplinary in character have also been constructed and taught in both college and high school as critical thinking courses. Topics that these courses sometimes focus on are law and justice, science and society, and others like these that cut across two or more traditional fields of study.

>> *Cautions about critical thinking courses*

Some cautions must be advanced about critical thinking courses at this point in our discussion. The first grows out of our comments so far. The range of skills taught as well as how they have application in the various contexts in which students will be called upon to use critical thinking skills in their lives, jobs, or professions must *both* be considered in designing such courses.

Courses that are designed to emphasize only a limited range of such skills (e.g., deductive reasoning skills) may, of course, do this very well. But no one should think that such courses teach all that is needed for critical thinking. Their scope and limits should be duly noted, and in cases in which there is a desire for a more comprehensive treatment of critical thinking, other courses may have to be introduced to supplement these.

Similar comments can be made about the type of *examples* given to students for practice in these courses. Practice in a limited range of *applications* for the skills taught—e.g., in assessing given arguments only—should be noted. Additional supplementary exercises, modules, or courses which help students gain practice in using these skills in broader settings—e.g., in solving complex problems or working through hard decision—could then be constructed to expand the range of contexts for the use of the skills to which students are exposed. The mapping we have provided above of how some of these skills can be embedded in broader problem solving and decision making activities may be helpful to teachers and university faculty who teach for critical thinking in standard critical thinking courses. It can guide in the construction of such supplementary material

A final caution has to do with transfer. There is much research that shows that students—even those who do well in critical thinking courses—have a tendency not to use the skills and strategies they learn in these courses in other contexts, especially in the context of their other academic work. This suggests to us that the effectiveness of such courses can be enhanced by *teaching directly for the transfer* of the skills taught into other academic and real-life contexts in which these skills can be used. This, in fact, is a *general* problem that has been raised in the field about approaches to teaching thinking that rely heavily on the use of stand-alone programs. Some of the techniques used to teach for transfer in infused lessons discussed in chapter 4, of course, have application here. In chapter 7 we will comment on these techniques in some depth. But there is a *special* practice in the

field today which is promoted by a number of stand-alone programs and speaks to this need. It has clear application in situations in which separate courses are the primary vehicles for teaching critical thinking. We now turn to this practice—of *bridging* the techniques of a stand-alone program into the regular curriculum.

Bridging Thinking-skill Instruction from Stand-alone Programs into the Standard Curriculum

On the next page is an example of part of an activity in which skills taught in a stand-alone program are bridged into the regular curriculum. Students in a high school biology course are given a lesson on distinguishing parts from wholes, but infused into their biology course (Schraer and Stolze, 1987, reprinted by permission of Allyn and Bacon).

Bridging involves superimposing a structure for a thinking activity—used in a stand-alone program with content not directly related to the standard curriculum—onto appropriate material *already in* the curriculum. The result is a thinking skill lesson designed to teach the same skill, but with regular curricular content. This is an example of *infusing* a specific thinking skill into a standard subject area of instruction. *Bridging* occurs when such infused lessons are created to *supplement* and follow up similar lessons that introduce the same skill to the same students through a stand-alone program (like those discussed earlier in the chapter). Its purpose is clearly *transfer*, as defined in chapters 3 and 4.

A second example follows, as well. The skills learned in the plane crash lesson can now be infused into a full-blown lesson in elementary science (Barman, *et al*, 1989, reprinted by permission of Addison-Wesley Publishing Co.).

Readers should note that in both of these cases we have included the entire lesson format with these bridged lessons. Both metacognitive components and further extended practice of the same skill are included in these lessons, following the model we described in chapter 4.

CRITICAL AND CREATIVE THINKING

Analyzing Parts-Whole Relationships

It may be relatively easy to pick out the parts of something, to understand or figure out the relationship between the parts and the whole may be more challenging. When you examine the components of an object, you not only observe how some of its parts contribute to the whole, but you also notice how its parts relate to one another.

Imagine, for example, that you are examining the components of a car. You observe how the engine makes the car run, the transmission delivers power to the wheels, the passenger compartment encloses both driver and riders, and the frame holds the car together. You observe other parts, such as paint, chrome, radio, and heater, that do not contribute to the operation of the car but do improve the appearance of the car and increase your comfort.

THINK CRITICALLY

In this activity, you will examine the parts-whole relationship for the American kestrel, one of the most common birds of prey in North and South America. Characterized by long, narrow, pointed wings and reddish-brown and slate-grey markings, the American kestrel is known for its habit of hovering in one place while hunting its prey, generally consisting of snakes, lizards, large insects, and small rodents. This evolved hunting skill involves the ability to detect any small movement on the ground, the ability to hover while scanning the ground for prey, and the speed and strength to plunge onto the prey from heights of 50 feet or more. All these skills depend on the kestrel's good sense of depth perception.

1. Compile a list of the parts of an American kestrel. Select one of these parts and break it down even further into its components.
2. Imagine that a kestrel was injured. How do you think the bird would be affected by an injured: (a) feather, (b) eye, (c) claw, (d) wing, and (e) tip of the beak?
3. Explain how the different parts of the kestrel would function together in stalking and catching prey.

THINK ABOUT THINKING

4. How did you decide which of the kestrel's parts to list in question 1? Can you think of any other system for coming up with a list of the kestrel's parts?
5. Describe the steps you took in question 2 in thinking about how each injury might affect the bird.

APPLY WHAT YOU HAVE LEARNED

6. Choose an object that you are familiar with and list its parts. Describe how the parts function together in the object as a whole.
7. Imagine that you are stranded on a desert island and want to make some kind of device to signal to passing airplanes. The only materials you have are a few long branches, a few pieces of clothing, some rocks, some matches, and a mirror. How would you use these materials to construct a signaling device? Explain how each part would function. (Note: You do not have to use all of the materials.)

Thinking Critically

Evaluating Sources

Gathering information by observing is one way you learn about the world. But sometimes you cannot observe things directly. You have to rely on the observations of others. For example, if you cannot go to a football game yourself, you may have to find out what happened from someone who was there and saw it. This person is an eyewitness.

Sometimes eyewitnesses are not reliable sources of information about what they observe, even if they are there. For example, eyewitnesses may be paying attention to something else. They may think they see things that are not really there. Some people even tell stories that are not true about what they observe.

You need to decide if you can trust the information you get from eyewitnesses. When you do this, you are evaluating the source of the information. Evaluating sources is a thinking skill.

1 Practicing the Skill

Imagine a volcano has erupted on an island in the South Pacific. Pretend you are a newspaper reporter and your assignment is to write an article about it. Here are some people you could talk to.

1. An island witch doctor
2. A passenger on a cruise ship that was offshore
3. A ham radio operator who saw the eruption
4. An island resident whose home was destroyed
5. A pilot who flew over the eruption as it happened
6. A 10-year-old island child

How would you evaluate these sources of information? Make a list of things you would want to find out about these people before you decided whether to interview them. Who would you want to talk to first? Who would you talk to last? Explain why your first choice is best and why your last choice is last.

2 Thinking About Thinking

What are the main things you thought about when you evaluated these sources of information? What advice would you give to someone who wanted to find out if an eyewitness to an accident could give reliable information about what happened?

3 Using the Skill

There are often times in school when eyewitnesses report about things that have happened. Write a short story in which five eyewitnesses claim they saw different things. Describe their circumstances so that readers will be able to evaluate which sources are reliable.

BEST COPY AVAILABLE

Why is bridging important? To us, bridging is *crucial* for the teachers, schools, and colleges which already use stand-alone programs or separate courses as the sole or primary vehicle to teach thinking. It helps to maximize our chances of teaching thinking well. Research in this field already indicates that the more teaching thinking which is based on a consistent and comprehensive plan and utilizes effective pedagogical techniques permeates the curriculum of a school or college, the more reinforcement good thinking receives. It then becomes more likely that students will incorporate the habits of thought we are trying to teach them into all their ways of thinking. Teaching thinking *solely* through a stand alone program minimizes its effectiveness. Students certainly receive a mixed message when, from 9:00–9:50 a.m. on Friday morning, they are taught from a stand-alone program about forms of good thinking—and during the rest of their school experience these forms are not used. This can undercut even the most well-meaning adoptions of such programs. While this may seem a caricature, the truth in it indicates to us the need to make infusion a central thrust of efforts to teach thinking.

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CHAPTER SIX

CONSTRUCTING A PROGRAM FOR TEACHING THINKING IN CLASSROOM OR SCHOOL: CHOICES ABOUT THINKING GOALS

Not all of the approaches that teachers use in teaching thinking aim at teaching the same sort of thinking, and not all attempt to teach what they do in the same way. How can we make sense of these differences in ways that will help us make wise choices about which approaches we may want to use? In this chapter and the two following, we take a careful and systematic look at the features of approaches to teaching thinking that practitioners must reflect upon to make key choices about what approach best suits their purposes. We intend to develop and provide a framework with which to compare and contrast different approaches to teaching thinking so that practitioners can have a clear sense about what they do and do not do—what their scope and limits are. Where the scope of common approaches is overly narrow, we will suggest some remedies that can overcome these limitations.

To make clearer the concerns we feel must be addressed in reflecting about the various approaches to teaching thinking, we note the following (concerns) about:

(1) what *kind of student thinking* the approach aims to improve (its thinking goals);

(2) the *instructional strategies* of the program (the techniques used to teach the thinking that is its goal); and

(3) the *support system* which particular programs provide to make it easy for teachers to use the approach.

We will speak to the first of these in this chapter. In particular, we will build on the discussion of what improves in teaching thinking and what kind of thinking it is important to teach from chapters 2 and 3. This will provide us with the concepts we need to outline both the spectrum of choices of emphases individual teachers have and how these different emphases should integrate together into a comprehensive program that aims at the thinking goals we set in these two previous chapters. Chapters 7 and 8 will speak to (2) and (3) respectively.

Setting Goals in the Classroom for Teaching Thinking

Do you remember the high-school American History example about the first battle in the Revolutionary War that we discussed at some length in chapter 4? If you were trying to decide whether you should use this lesson in your own classroom, how can you do this in a reasonable and systematic way?

This, of course, turns in part on the *content* of the lesson. Is it important for students to learn about the Battle of Lexington? Why? In learning about this battle, what, in particular, do you want them to learn? These content goals should be distinguished from the goals of the lesson that are related to the *kinds and aspects of thinking* that it is designed to foster. Do these also coincide with your classroom goals? If you are an American History teacher, the Revolutionary War is covered as part of your curriculum, and one of your goals as a teacher of thinking is to teach students to develop skill at determining the reliability of sources of information, this lesson becomes a lively candidate for accomplishing this goal. Other matters, for example about lesson design, must then be considered. But *should* teaching this skill be one of your goals?

Individual teachers can, of course, adopt a catch-as-catch-can attitude towards their goals in teaching thinking: get whatever kind of thinking instruction as one can into a particular episode of teaching when opportunities present themselves. We feel, however, that making choices for the classroom is best accomplished in the context of an overall classroom or course plan which, in turn, is part of a more comprehensive plan for the program, school, school district, or

college within which the classroom or course is located. There are two basic questions here:

1. What specific thinking skills, activities, and attitudes should a particular program, school, (etc.) aim at helping students develop and improve?
2. In what curricular contexts is it best to teach to these goals?

Formulating these questions in this way leaves open a broad range of options in setting goals for teaching thinking. The answer to the first question may vary widely from program to program, depending on the differing missions of specific programs (e.g. science, good writing, providing quality medical care) and special circumstances (e.g. the age levels of the students). Or there may be some comprehensive set of goals that spans a number of programs (as we have indicated across-the-curriculum infusion projects embrace). The answer to the second question may vary widely also depending on, for example, what configuration of separate instruction and infused instruction is felt to be best in particular cases, and whether the instruction is sequenced from grade to grade. Let us now turn to how some of these decisions can be made.

Strategies for Establishing the Goals of a Thinking Program

There are many lists of thinking goals for teaching thinking in published material presently available. These include comprehensive taxonomies of thinking skills and activities, more specific ones for certain kinds of thinking like critical thinking, and various subject specific taxonomies (e.g. in science and history). There may be some virtue in consulting these both at the program and classroom level in trying to develop a set of goals for teaching thinking. Those who have developed them have usually given long and careful thought to this question.

Relying on such taxonomies, however, carries certain risks with it. Many that purport to be comprehensive, for example, leave unspecified whole ranges of skills that appear in other taxonomies. Are they leaving out important skills that should be included in a statement of goals for teaching thinking? Furthermore, do you know

that these goals fit your particular educational setting? They may. But they may not. What is needed is a way of checking any particular proposal for the thinking goals of a specific classroom or program.

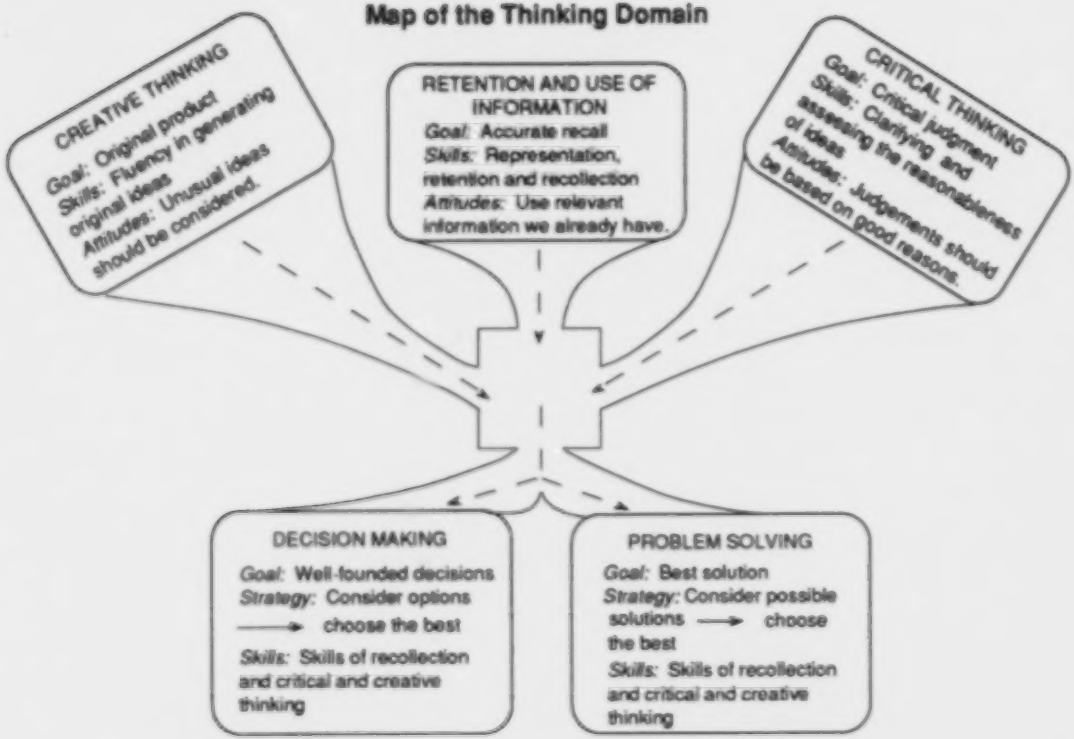
In chapter 3 we discussed the kinds of thinking that should be the targets of instruction. The discussion there can help to provide us with a framework that can be used to monitor the comprehensiveness of any particular set of goals for teaching thinking. On the next page is the map we introduced in chapter 5 to show the relationship between these different kinds of thinking.

We suggest that any comprehensive program designed to teach thinking should be guided by this map to emphasize in a coordinated way *all* of the different ingredients of thinking mentioned. Indeed, this map indicates that more must be done as well. It stresses important types of thinking skills, attitudes, and strategies that are useful in holistic thinking tasks like those involved when we face problems to be solved and decisions to be made. This means that it is equally important to set as a goal that we teach students *when* to use these skills and display these attitudes. This includes both everyday contexts as well as those in specialized jobs.

Individual teachers or university instructors can define *their* goals in such a comprehensive program by asking what kinds of thinking their students will have to do in the roles they are learning to step into, and in which typical situations they will have to do such thinking. Particular skills and attitudes that will be most helpful in doing these well and that fall into the categories on our map should then be articulated to flesh out the classroom focus in teaching thinking.

Doing this involves performing a *thinking-task analysis*. Here are some guidelines for this type of analysis. Find some rich examples of complex tasks that you want students to perform well in their lives and/or in their jobs (e.g. deciding for whom to vote). Describe these in some detail. Then, using the categories on the map on page 133 as a guide, analyze these examples to articulate the specific thinking skills and activities that you feel students must be proficient in to be able to perform these tasks well. Emphasize those

Map of the Thinking Domain


CREATIVE THINKING
Goal: Original product
Skills: Fluency in generating original ideas
Attitudes: Unusual ideas should be considered.
RETENTION AND USE OF INFORMATION
Goal: Accurate recall
Skills: Representation, retention and recollection
Attitudes: Use relevant information we already have.
CRITICAL THINKING
Goal: Critical judgment
Skills: Clarifying and assessing the reasonableness of ideas
Attitudes: Judgements should be based on good reasons.
DECISION MAKING
Goal: Well-founded decisions
Strategy: Consider options → choose the best
Skills: Skills of recollection and critical and creative thinking
PROBLEM SOLVING
Goal: Best solution
Strategy: Consider possible solutions → choose the best
Skills: Skills of recollection and critical and creative thinking

thinking skills and activities that you think students, who come into the particular program, need help to develop or improve to perform these tasks well. In addition, indicate what thinking attitudes you feel those engaged in these tasks should manifest to impel their thoughtful performance. Then either extract a list of thinking goals for your program or, if you are considering an already existing set of goals proposed by someone else, check it against the result of your analysis. Modify it, if necessary, to suit your particular needs. Let's look at the kind of task analysis that can yield such a result.

An Example of Good Thinking

To illustrate how such an articulation of this map can be developed, let us look at an example of some real thinking many readers will find familiar, and that many of the students we teach may have to do one day as well. We choose one that most readers will be able to relate to from their everyday experience. As you work through this one it will be easy to see how countless other examples from more specialized endeavors can serve equally well.

>> *Going through a process of thinking*

Let us suppose, then, that you drive to work in the morning, and that when you do you usually get stuck in traffic that sometimes makes you late. While you have been resigned to this in the past, it has become a more serious problem. You now wonder if there is anything you can do about it. This starts you thinking.

What do you think about? The natural "first step" is to consider whether there are any alternatives. What other ways could you go? You may map out a few either on paper or in your head. As you do, you take note of some important things that are relevant to what you already know about these routes. There is almost a sense of discovery as you remember some of these. "Of course! Elm Street runs west for quite a distance, and, for that matter, so do Spruce and Maple Streets. These could perhaps get me there." But there are still unanswered questions you have about them. How heavy is the traffic on *these* streets in the morning? Are there many traffic lights? You could, of course, go and check out how many traffic lights there are, making sure you do this in conditions that are suitable for accurate observa-

tion. But you may not want to risk trying one of these streets in the morning, only to find out there is even worse traffic on it. So you might seek out some reliable source for this information. In any event, when you've gathered as much as you can, you may be ready to make your choice. It may be a clear choice; one route may stand out as the best. Or it may be more murky. Perhaps you have narrowed things down, and you should try a few of the likely candidates to see if there is something you have missed. So you will keep your options open for a while. Then, when you do try these out, you may find additional information that makes you reject one of these as not viable anymore, now leaving one clear choice. Now that wasn't too bad: a little clear headedness and persistence and perhaps you have found a better way to get to work, without those annoying traffic jams!

This is an organized piece of thinking with a goal that was accomplished: a new route to work that it was reasonable to think would get you there without the headaches of your standard route. Of course, you could be wrong; we always run that risk. Maybe something unforeseen will happen; e.g., a broken water main. But in the circumstances, you've done some thinking that maximizes your chances of making a wise choice.

>> *Analyzing the thinking*

Now let's look at what was involved in this thinking process. Clearly, this involved a systematic process of decision making. In the course of it, information you already had was brought to bear for active use and related to other information by both creative and critical thinking. These forms of thinking involved the use of specific skills at appropriate times, such as using reliable sources for information and predicting results based on evidence. How, specifically, were these different ingredients involved? In particular, what were the *skills* used, the organizational *strategies* employed in making the decision, and what *attitudes* impelled the thinking with care and precision?

How is the active use of information involved? First, consider the role *information you already have* can play in such thinking.

There is much that may be relevant. You may already know about side streets that lead in the direction of your job, have a fair idea about the way the city or town you live in is laid out, know how fast you can drive in these areas, etc. But that information may have come to you piecemeal, over a number of years, and not while you were thinking about how to get to work. And you may not readily remember it all. Still, there is much that you are not ignorant of and that can be helpful to you in thinking about this question.

Our ability to draw upon information we already have in thinking about this question may depend on how we represent the information, that is, how we conceptualize and categorize it. For example, looking for a street that heads west and then thinking of a street we already know (and which we normally think of simply as Elm Street) *as that kind of street* makes it easier to consider Elm Street as part of a potential alternative route to work. Classifying Elm Street in this way turns fundamentally on our ability to classify things in a multitude of different—and sometimes new—ways. You may say to yourself: "To start out on a new route, I need to find a street that heads west. Which streets that I already know about fall into this category?" Of course, our confident use of this information also turns on judgments we make that these ways of classifying the street are accurate. Hence, even as we draw information out of our memories for use in solving this problem, we make use of critical and creative processes.

In addition, thinking of Elm Street *as a link* in a more complex route to get to work turns on our abilities to think of the street as a part of a more complex whole, just the kind of analytical skill we spoke of earlier in this book.

How is creative thinking involved? The way we *use* such information turns on both creative and critical thinking. Fundamentally, this is a matter of relating it to other ideas we have in very specific ways in order to think through whether there is a good alternative way to get to work without getting stuck in traffic. For example, we may be trying to come up *with a number of different possible routes* to take to work that will be alternatives to the one we

normally take. Doing this could involve us in open brainstorming about possibilities. We could try to list a number of commonly used alternative routes as well as some new ones that we had not thought of before. Such brainstorming is typically conducted prior to judging whether any one of these is to be preferred to the others. This is a paradigm often offered of the use of specific *creative thinking* skills, e.g., skills of fluency, flexibility, and originality. It is, of course, in this context that we fill in these alternative possibilities with information we often already have and retrieve in the ways described above.

How is critical thinking involved? When we consider whether some of these routes are better than others we employ specific *critical thinking skills*. For example, suppose we think about Elm Street as a potential link in an alternative route to work. This usually brings along a whole lot of other information about Elm Street that we may already have as well. This is because when we think of it as *an alternative route* this helps us to formulate questions that we should seek answers to that can help us decide whether it is a good route. When we gather answers to these questions we have information we can weigh to make a critical judgment. In particular, we do this through a sorting-out process. This judgment is based on standards that we employ in choosing a viable alternative route: will it get us to work and will it get us there faster? When we answer these questions, we make predictions. These predictions themselves must be well-founded and based on the application of critical standards.

In the end, both critical and creative thinking skills structure the use of information appropriately represented to be helpful in making a reasoned decision and solving a problem well. This is how good thinking operates. But these skills are not used in a haphazard or random way. They rather interweave and are employed in an *organized* way in this thinking. Finding a way to get to work to avoid the traffic involves tackling a problem. Choosing the best way to do this involves making a decision. The strategies we use to organize our thinking when we are trying to solve problems and make decisions are the essence of careful and thoughtful decision making and problem solving.

How is organized problem solving and decision making that interweaves these different forms of thinking involved? Such patterns of decision making and problem solving are also easy to spot in this example. Options are considered, their pros and cons weighed, and a choice made to solve the problem. One frequent way that we restrict our problem solving is to take problems as given. But it is important to think through ways of reformulating—representing—problems to ourselves before we try to find solutions. If I think that the problem about getting to work is finding an alternative route, for example, I limit myself to looking for routes other than the one I usually take. But I need not work within such a restricted way of formulating the problem. Rather, I could formulate the problem as one of getting to work on time and avoiding the traffic snarls that I run into when I go my usual way. This reformulation of the problem (something urged as a good way to *start* a problem-solving process) opens up other possibilities. For example, I may also consider taking the same route but starting out a half-hour earlier. Perhaps at that time there is not so much traffic. Of course, this different way to solve the problem must be assessed as well. Is it accurate to say that a half-hour earlier there are no snarls? Perhaps I have to leave an hour earlier. But then, perhaps in getting up that early I will have a conflict with my children who have to use the bathroom at that time to get ready for school.

Reformulating the problem to begin with should be no mystery. As described, it involves uncovering assumptions we may make about the situation I start out with that may restrict my options, and assessing these assumptions. In this case, I would be assuming that my choices are restricted to options I have when I start out at the same time as usual. Another assumption I make that could lead, when examined, to a different way of reformulating the problem is that I have to go to work by car. So there may be many more ways of stating the problem that open up a variety of other options. Both critical and creative thinking skills, as well as the use of relevant information, are bound up in this important aspect of problem solving.

What attitudes of thought are involved? Good thinking, as it appears in this example, also turns on attitudes of openness and rigor

that impel these activities towards well reasoned solutions or decisions. Thus, if I am too impatient I may not remember that one of the streets on my preferred alternative route is one way the wrong way, or is being repaired. Or if I don't know this already, I may not take the time to find out. Alternatively, I may be hasty in my consideration of options and not think to consider other routes that begin by cutting across town for a while going north or south. Such a route may turn sharply west again and also have the advantage of not having any traffic lights along the way. In the end I may pick one alternative as the one I should try because it is the shortest, but overlook the signs that say "Street closed for cleaning every morning from 8:00 to 9:00 a.m.!"

The remedy for these defaults in decision making lies, by and large, in developing attitudes like persistence and patience, as well as in seeking all the relevant information we can find in the circumstances. There is no substitute for such careful and systematic thinking when it is important and we have the time. Of course, making a well-considered decision must sometimes be balanced against the need not to take too long in deciding what to do. In cases in which we do have to make quick decisions based on sparse information there are other retrospective attitudes that are important to adopt. We should be willing to acknowledge that such decisions are riskier than more thorough ones and keep in mind other things that we might find out after the fact that could change our minds. If the decision is irrevocable, we at least can acknowledge uncertainty when we make the decision, and not be so self-critical if the decision turns out to be wrong.

Now that we have analyzed this example by enquiring as to what specific instances of critical thinking, creative thinking, and the active use of background knowledge occur, and how organized patterns of decision making and problem solving are involved, it is time to make these results more systematic. On the assumption that we all feel that it is important to teach our students skills they need to perform this and similar tasks in contemporary society well, this means that we will be trying to translate our analysis into an initial set of goals for teaching thinking. How can we effect this translation?

Developing an Organized Set of Thinking Skills Goals

The most common thinking emphasis in approaches to teaching thinking is on thinking *skills*. In most thinking skill projects a number of *discrete* skills are differentiated and individual activities or lessons designed to teach these skills. As we have seen, the content of these lessons can vary from minimally challenging familiar things, such as shapes, to more complex situations, such as a historical battle. But it is characteristic of approaches which stress thinking skills that, no matter what the content, their goals are very specific thinking skills that are taught one by one. Hence, listing the thinking skills that are important in tasks like the above is a good place to start a more systematic statement of goals in teaching thinking.

We have suggested that the three broad categories of thinking that we discussed in chapter 3 can serve as a way of organizing lists of important thinking skills as goals of a thinking program. These broad categories are, if you remember, the following:

Table 6.1. Three Categories of Thinking

Skills at Learning and the Active Use of Knowledge
(Skills at Representation, Organization, and Recall of Ideas)

Creative Thinking Skills
(Skills at Generating Novel Ideas and Perspectives)

Critical Thinking Skills
(Skills at Clarifying and Assessing the Reasonableness of Ideas)

Returning to our example of getting to work a better way, here is a short list of some of the core skills that can be generated:

Useful Retention of Ideas	*Generation of Ideas*	*Assessment of Ideas*
Classification/ definition	Multiplicity of ideas	Finding reasons/ conclusions
Comparing/ contrasting	Varied ideas	Finding assumptions
Parts/whole	Novel ideas	Accurate observation
Ordering ideas	Elaborated ideas	Reliable sources
Pattern recognition	Composition of ideas	Causal explanation
Relation to previous knowledge	Challenging assumptions	Prediction
		Generalization
		Analogy
		Conditional reasoning

>> Thinking skills goals for K–12 education

These skills are candidates for a set of thinking skills goals for K–12 education, because one of the primary missions of K–12 education is preparation for living effectively in contemporary society. To be sure that this is a complete and comprehensive set of goals, we have to be sure that we haven't omitted others equally important.

The analysis of one example is insufficient evidence on which to base a set of goals. In addition to ordinary tasks like the above, we also want students to use what they learn about nutrition to make wise choices of foods they eat and to use what they learn about political history of their country to make wise choices about the candidates they vote for. This list can be multiplied. It may be that in analyzing a broader variety of such complex thinking tasks you will either expand your list of important thinking skills or keep it much the same. This is merely a start and until other complex thinking tasks are also

analyzed it is hard to decide how complete and comprehensive this list is.

We do not want to oversimplify the mission of K–12 education. Many educators *have* argued that specialized courses (e.g. science and history courses) should have, as their primary goal, the education of students so that, in their daily lives, they become literate users of information which is generated by others who are the true developers of new knowledge in these fields. But eventually some students will play the role of researchers in fields like science and history too. This raises another question about the generality of the results of this analysis in setting goals for K–12 education.

We suggest that more specialized complex thinking tasks must be scrutinized to determine the thinking skills needed to perform these tasks well. What is a typical problem that someone with a good science background and working for a government environmental quality monitoring office would be called upon to solve? What thinking skills would this person need to apply? Similarly, what about a news reporter? A historian of the Vietnam War? A nurse?

This, too, may add more complexity to our initial list of thinking skills. One approach to clarifying what thinking skills are important when we work within specialized fields of knowledge is to develop separate skills lists for each of these specialized fields. But this may miss commonalities between fields. Another approach is to work from a common core of skills such as the above, and indicate two basic variations due to the needs of specializing thinking tasks. The first of these involves *differences in frequency of use and importance of certain thinking skills* in contrast to others that may be important in other fields. For example, in mathematics certain skills like determining the accuracy of observation and causal explanation may have less frequent use than others like reasoning by analogy, uncovering assumptions, and deductive reasoning. The second involves the possibility that certain thinking skills are *idiosyncratic* to a particular speciality area. Whether there are any such subject-specific skills is presently an unresolved issue in the field.

In liberal arts colleges, that take as part of their mission to provide a core of learning for all students, a similar articulation of a common

core of thinking skills goals for the college program makes much sense. There is likewise the same tension between approaches that stress a common set of generic skills, allowing for some variation of emphasis and even kind, as we move from speciality to speciality, and approaches that are highly decentralized, defining thinking skills from field to field. Our own view is that articulations of skills like the above provide a core of generic skills that cuts across the curriculum in both K–12 programs and in colleges. This is what makes teaching thinking across the curriculum in ways that stress the *transfer* of thinking from field to field, as we described in chapter 4, a viable approach to teaching thinking. That, of course, leaves open the possibility of either or both of the variations due to the demands of thinking in specialized fields that we mentioned in the previous paragraph.

>> *Thinking skills goals in specialized educational settings outside K–12 education*

The primary purpose of this extended analysis of a complex thinking task has been to illustrate how one can use the categories of thinking we set out in this book to develop a set of goals for teaching thinking. One upshot of this discussion has been that such goals are highly context dependent — that is, they depend on the missions of the educational programs to which they are tied. This applies to highly specialized educational settings as well. These range from those found in trade schools to those in schools of engineering, medicine, and business.

It is our contention that critical and creative thinking and the active use of information interweave, in ways similar to those uncovered above, in every specialized field of study. Some of the tasks called for in these fields may, to be sure, make use of highly technical information. Medical diagnoses and the treatment of diseases requires a great deal of technical expertise, as does accounting. But to perform normal complex tasks well in these fields requires critical and creative thinking skills together with the active use of knowledge in problem and decision situations. Hence, we urge the use of the same techniques of thinking-task analyses to define the thinking goals of these programs.

>> Clarifying thinking skills goals: breaking out a skill

A list or taxonomy of thinking skills like the one developed on page 141 is usually not enough to *clearly define* the thinking skills goals of an educational program. We remarked earlier that thinking skills terminology is not used in this field with any degree of consistency. But even if it was, it would still be important to get behind the words used for specific thinking skills and get a good sense of what makes the thinking in question skillful. This is because such skillfulness is what we aim at in teaching these skills.

The need for this type of clarification of thinking skills goals can be seen from the following scenario. Suppose that a teacher is concerned about helping students think better. She recognizes, for example, the need to teach her students to engage in better causal explanation. She realizes that when they make judgments about causes they usually either just guess or make very hasty judgments with little attention to evidence (like Chicken Little). Causal explanation is a thinking skill that is on the school's list of thinking skills goals. So with good intentions this teacher starts introducing "higher-order questions" into her classroom. Instead of primarily quizzing her students in ways that prompt recall of what they have covered in the textbook, she asks them *why* certain things that they are studying happened. She asks these questions in situations in which no specific explanation is given in the textbook they are using. For example, she asks: Why did the plague spread so rapidly in medieval Europe? and Why did Huck Finn run away? Her students think about these things and come up with answers to her questions.

Many of these students no doubt do more in their thinking than simple recall. Still, it is risky to think that the goal of *improving* the way these students think about causes is achieved. By and large, this type of questioning gives students the *opportunity* to think about causes. But if they don't do this too well to begin with, it is not clear that they will do any better during or after this exercise. If they usually make guesses or hasty judgments about causes, all this activity will probably provide is another opportunity to do so. The problem here is that if our goal is to *improve* our student's thinking by helping them to reorganize it when they think about causes, what

we should aim at is not made explicit by merely indicating that the skill of causal explanation is one of our goals. There is a need to make clear what it is about causal inference that involves improvement in the way students think.

Breaking out the skill provides just this indication of the specific goals we may want to embrace to do this. Breaking out a thinking skill involves articulating *points to focus our attention on* when our thinking is skillful. Indeed attending to these is what brings better organization to our thinking. The end result of breaking out a skill is a skill map of the sort that we described in chapter 4. Here is the skill map we included there for causal explanation:

(1) List a number of different possible causes for the event in question.

(2) Describe evidence that you might find for and against the likelihood of these being the real cause.

(3) Collect and organize the evidence you find.

(4) Weigh the evidence and make a judgment of a likely cause. When there is strong evidence in favor of one and evidence against the others, judge it to be the best explanation.

When the instructional goals of teaching the skill of causal explanation are stated in this way they provide more guidance to individual teachers as to what they should aim at to help students improve their thinking. A teacher who uses this map would be guided to ask students to come up with some possible explanations for Huck Finn's behavior, for example, perhaps using brainstorming as a technique, and then to ask them to search the text to find evidence that helps them sort out which of these is the best explanation of Huck's behavior. In chapter 7 we discuss a number of instructional strategies that can be used to accomplish this. In contrast to simply asking students why Huck Finn ran away, this can lead to real improvement in the organization of students' thinking.

Maps like this one should not be taken to prescribe a step-by-step procedure that people should go through in engaging in causal explanation. Our thinking may or may not be sequenced in this way. These are attention points whose spirit is to flag important things to attend to in doing this kind of thinking, no matter what their order is.

Where can such thinking maps be acquired? There are two basic sources. You can get these from already published material and from well-articulated school plans. Or you can develop them yourself.

Some thinking skills are broken out in already published material. An example of a thinking skill elaborated in this way is included in chapter 8. A running description of skillfully determining the accuracy of an observation —a key critical thinking skill— is reproduced there from a published science series. In chapter 8 there is also a description of a process whereby a group of teachers develops its own map of the skill of making a well-founded prediction.

As paradoxical as it may seem, there is no one correct map which captures all there is to doing causal explanation skillfully. There are different maps which vary in the degree to which the skillfulness of the thinking is articulated. Which one is used depends on the context of instruction. The map of causal explanation provided above highlights four improvements in thinking about causes which students can learn. But there may be others. In more advanced work teachers may want to articulate these further. For example, the notion of "strong evidence" is left unclarified in (4).To become skillful in determining how strong evidence is for a causal explanation what do we do? Various methodological techniques like using evidence from controlled experiments may be important to teach in specific circumstances (e.g. in high school and college science courses).

Even a less articulated description of skillfullness in causal thinking may sometimes be appropriate. Here's one:

> Finding causes: this is a type of reasoning in which it is argued that something caused or brought about something else. Evidence is used to support whatever conclusion is drawn about the cause.

This might be used in certain elementary school contexts in which the primary concern is to get students to attend to evidence for causal judgments. Perhaps later they will learn some of the subtleties reflected in the map of (1) – (4) on page 145.

These maps differ in degree of skillfulness. How well-articulated we make these goals depends on the circumstances of instruction and the needs of our students. But we should always tell it as it is. If the

less articulate rendering of causal reasoning is used as a goal statement and instruction is based on it, we should not claim – or hope – that the kind of skillful causal reasoning reflected in (1) – (4) will be achieved through our instruction. This is why it is so important to be clear in any statement of the goals of thinking skills instruction what is behind such terms as "causal explanation," "distinguishing reliable from unreliable sources of information," and even such thinking skill terms as "comparing and contrasting" and "classifying."

Thoughtful Decision Making and Problem Solving as Goals

In addition to stressing specific thinking skills, a number of programs and projects emphasize some of the broad thinking activities we have also isolated as important to teach. Chief among these are decision making and problem solving. Typically, these approaches give students decisions to make or problems to solve, and the instructor takes them through a process of careful thought in making such decisions or coming up with problem solutions. What is the difference between programs and approaches that emphasize these forms of thinking, in contrast to specific thinking skills?

To us, this is a difference of degree. Problems solving and decision making are broad forms of thinking that are involved in a wide variety of things that we do. We make decisions every day of our lives. Sometimes these decisions are about "big" things, such as a job change, or "little" things, such as whether to have whole-wheat or rye bread on a sandwich at lunch. Moreover, they can occur in the context of our ordinary experience with the world around us, like deciding what route to take to work, or in highly technical situations, like deciding about the best method for storing nuclear waste. Similar comments can be made about the varieties of *problems* we see ourselves confronting in the world, the amount of technical knowledge required to develop good solutions for them, and the degrees of importance that we attach to solving them.

Like thinking skills, models for good decision making and problem solving involve characteristic *patterns of thinking* that can

be learned. But at the same time, their scope is greater than the subskills of good thinking, and, characteristically, these subskills are often used together in various combinations in solving problems and making decisions well.

It is worth elaborating this point a bit. Like various approaches to teaching thinking skills, those that focus on decision making usually commit themselves to the idea that each of these types of activities operates in a number of contexts and that there are common patterns of thinking that cut across these. Whether we try to solve problems about the treatment of illnesses in medicine, in our family relations, in budgeting our income, or even in more restricted settings such as in mathematics, there are certain basic organizational patterns that define good decision making and problem solving. This is the case despite the fact that to make good decisions or solve problems well in these varying areas also requires an appropriate knowledge base in the area, and that does vary from domain to domain.

>> *Emphasizing strategies for decision making and problem solving*

In a fifth-grade classroom, three groups of students have formed. They have just watched a film strip in which a girl, who has just promised her father not to climb trees because it was dangerous, comes across a friend who is distraught because his kitten is stuck up in a tree. Should she climb the tree to save the kitten, or keep her promise to her father? One of the groups thinks she should climb the tree, another thinks she should not, and the third is not sure. While the third group is formulating questions they would want to have answered to help them decide, each of the first two groups is busy discussing the best reasons they can come up with in support of their positions. This is the prelude to a heated—but nonetheless guided—discussion in which the teacher tries to help the student develop some strategies for thinking about the question carefully and systematically.

The story of the cat in the tree—left deliberately open-ended—is designed as a vehicle for this kind of teaching. Other teachers

who do not have access to such materials stop stories that children read in their language arts program at key decision points for the same purpose. What should Jack do when he reaches the bottom of the beanstalk with the goose that laid the golden egg? Even stories that have resolutions can be used as such vehicles. Should Jack have chopped down the beanstalk? And, of course, historical events can prompt similar thinking. Remember the quote from Harry Truman about bombing Hiroshima? Should he or should he not have? To this day people debate this issue.

Raising these questions is usually only a starter in an organized process of instruction. It works in the following way. Initially, the first two groups state their reasons followed by the third group which raises the questions they have formulated. As the third group tries to have their questions answered, the teacher guides the discussion. For example, when the undecided group asks whether there was anything else that could be done so that the girl could keep her promise and yet help to get the kitten down, she asks them to pause and list as many alternatives as they can generate. Then she asks them to think about whether any of these alternatives are viable ones. What are the pros and cons of each? Did either of the groups that had made up their minds already address this question? What did they say that was relevant? The teacher alternatively lets the discussion go on but brings it back again to this theme of thinking about whether there were other options, and what the pros and cons of the various possibilities were.

The teacher then focusses the students on the *value conflict*. Assuming that there were no other options, what have we already said that helps us think about the pros and cons of the two we started with? This leads to a discussion about whether it is ever ethically correct to break a promise. In the end, she asks her students to think about how they feel now and to take a position only if they feel they have good reasons for it.

There is no doubt that making better decisions and solving problems more effectively is important. What we have just de-

scribed is an instructional context in which a teacher is trying to help her students develop habits of thought that she feels will make them better decision makers and problem solvers. She is teaching decision making by emphasizing an orderly strategy for making decisions. She stresses again and again the need to think about options and then about the pros and cons of each in good decision making. This emphasis on orderly decision making strategies—not unlike the emphasis on structured thinking in using specific thinking skills—is a good example of the kind of material that teachers strive to teach their students in emphasizing decision making and problem solving in their teaching. It is an *organized strategy* for decision making. It defines the kind of thinking that is the goal of such efforts.

We have already indicated a certain vagueness and overlap between what are commonly called *problem solving* and *decision making*. In many ways, one can view decision-making as a special case of problem solving, or *vice versa*. Thinking of working through a type of problem as *decision making* depends on whether we are thinking about choices we have about what to *do*; thinking about it as a *problem* that has yet to be solved puts the stress on other things that are important in our *thinking*. For example, if I have to make a decision about the person for whom to vote, I may emphasize considering the various pros and cons of the options I have. If I feel there is a problem with my weight, before undertaking any particular solution, I may want to spend time thinking about what kind of problem it is, e.g., my eating too much, the kinds of foods I am eating, my glands, etc. Still, aside from these emphases, there are common ways that these activities are usually articulated. On the following page are two rough diagrams mapping the different ingredients that many who are concerned with problem solving and decision making advance as components:

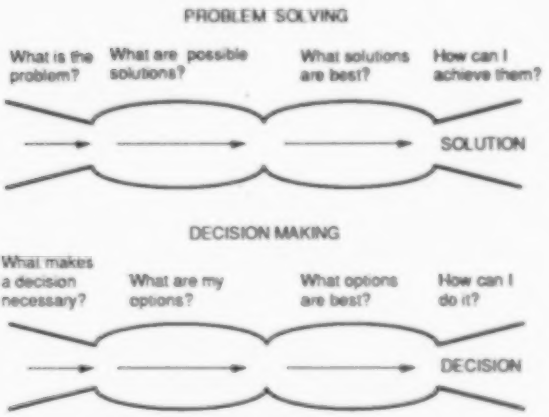


Figure 6.1. Models of Problem Solving and Decision Making

The most common approach to teaching decision making and problem solving employs models like these to stress *systematic* decision making and problem solving in instruction. Here are some important ingredients that typically appear in such models:

- practice at considering multiple options with regard to either problem solutions or possible choices;
- practice in looking carefully at the pros and cons of each option without bias;
- thinking openly about any conflicts in value priorities in weighing the pros and cons to make a decision; and
- adopting a solution or making a decision based on these considerations and not based on emotion or impulse.

Each of these is, of course, very important since not doing these things often gets us into trouble in making faulty decisions or adopting solutions to problems that do not work.

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This articulation of decision making and problem solving define what is meant by these terms. In a great many cases in which decision making and/or problem solving are the stated goals of a particular approach (and this is what is meant by these activities of thought), what is taught to students are strategies for organizing their thinking along these lines. These provide a rough ordering to the thinking we should do to maximize its chances of being effective and successful. This is another way to see that the difference between such approaches to teaching decision making and problem solving, on the one hand, and thinking skills on the other, is a matter of degree. Nonetheless, for the reasons stated, it is an important difference of degree.

Problem scope

There is one special caution that we must emphasize in considering problem solving, in particular, as it is reflected upon and represented in the field today. This has to do with problem scope and character. Programs that identify themselves as problem solving (or decision making) programs can range in their focus from problems that are open, not strictly defined, call for creative solutions, and/or are subject to the application of our values, to those that are more restricted and very well-defined. The latter call for the use of set procedures to arrive at the one correct solution. The term "problem-solving" is used in both cases. Problems in pure and applied mathematics and in sciences, such as physics and chemistry, in which we have a lot of "givens," and in which we must come up with a single correct solution, typify the latter. These tend to be artificial and used in programs for practice in using mathematical or science skills. Many problems in our lives (such as how I can "make ends meet" on my salary) typify the former. Both are, of course, important to help students do better.

We should have no illusions here about using programs and activities that focus on problem-solving in the more restricted sense and expecting students to gain facility in dealing with the less well-defined problems we face in the broader types of prob-

lem solving we must do in our jobs or in our everyday lives. We say this despite the fact that many teachers of mathematics and subjects like chemistry say that because students solve problems in their subjects they are learning the kind of thinking they need to be good critical thinkers and general problem solvers. Here is an example of a typical "problem" posed to promote "problem-solving" in chemistry (Dorin, 1987):

Sample Problem

The concentration of a 0.200-liter hydrochloric acid solution is 0.80 molar. How many moles of HCl are in this solution? How many grams of HCl is this?

Solution: The volume of a solution in *liters* multiplied by its molar concentration gives the number of moles of solute in the solution:

$$\text{moles of solute} = \begin{pmatrix}\text{volume of}\\ \text{the solution}\\ \text{in liters}\end{pmatrix} \times \begin{pmatrix}\text{molar concentration}\\ \text{of the solution}\end{pmatrix}$$

Substituting the numbers given in the problem into the above expression gives:

$$\text{moles of solute} = 0.200 \text{ liter} \times 0.80 \text{ moles/liter} = 0.16 \text{ mole}$$

Our result is that 0.200 liter of a 0.80 *M* HCl solution contains 0.16 mole of HCl. To convert to grams, we note that

$$0.16 \text{ moles HCl} = 0.16 \text{ mole} \times \frac{36.5 \text{ g HCl}}{\text{mole}} = 5.8 \text{ g HCl}$$

The thinking skills used in this type of problem-solving are mainly classification and deductive reasoning. Its real importance lies in gaining facility in using the language and principles of chemistry together with the use of mathematical skills to make certain quantitative calculations.

Consider, on the other hand, the broader array of thinking tasks that a person would have to engage in who worked for a government department of environmental quality and who was given the task of problem solving connected with complaints

made by local residents in a community in the state that their drinking water was contaminated. This person would have to gather information to ascertain whether there really was a problem and determine what it was. Skillful sampling of the water supply would have to be done, tests conducted, and careful generalizations made. In doing these, the person would use knowledge he or she had already acquired. Information would have to be gathered and used from reliable sources about toxicity levels, if any, of the chemicals found in the water. The issue of what was *causing* the problem would have to be investigated. Causal inferences would have to be made based on reliable evidence gathered through accurate observation, from others, and from the stored information the person already had. After some reasonable conclusions are drawn options will have to be considered about what can be done to solve the problem. Here there is room for some creative thought against the backdrop of the special circumstances that might be involved in the social world of the community and any corporations that may be involved if the problem suggests possible industrial pollution. And, of course, it is crucial to consider the consequences and outcome of each of these options to determine their feasibility and to pick the best one to recommend.

In this case, quite a bit of technical knowledge in chemistry is essential, and the skills acquired through practice on chemistry problems like the one described above are important to use. But these will by no means be sufficient. Other skills are needed to carefully solve this problem.

Solving everyday problems is analogous to this, although it usually does not require the use of such technical knowledge and skills. Hence, programs that aim at the development and systematic use of the kind of thinking necessary to deal with such problems effectively teach more skills than we acquire in working on more restricted types of technical problems found under the heading of "problem solving," such as the chemistry problem about moles. It is not hard to recognize programs and infusion projects that explicitly stress problem solving in its broadest sense. Using a map like the one in figure 6.2 as a guide

can help to define the scope of a particular problem-solving activity or program.

Stressing Other Thinking Activities

Problem solving and decision making are by far the most extensively covered types of thinking emphasized in approaches to teaching thinking that stress learning organizational strategies. But there are others that appear as well. Claims that these, too, are important kinds of thinking to be taught are often made. Here are some examples:

- the writing process,
- experimentation in science,
- reading comprehension,
- computation, and
- studying.

These, indeed, are thinking tasks, as are a great many other activities in which we engage. In particular, these are tied to specific domains, such as science, communications media (e.g., the writing process), and emphasize certain goals, such as studying. Each can, perhaps, be analyzed into specific thinking strategies in these special contexts. However, while we find some of the work in which these processes are emphasized appear promising, at present they remain by and large outside the mainstream of work in the field of teaching thinking. Usually, what is lacking is a clear articulation of how thinking is involved in these activities, and a clear emphasis on the kinds of thinking skills involved. We mention these here, however, not to emphasize faults with the way these topics are treated. Rather, we wish to point the way to further work in defining the goals of these instructional approaches in terms of the categories and conceptualizations of thinking presently embodied in mainstream work on teaching thinking. As of now, however, these areas remain too underdeveloped to pro-

vide us with clear articulations of specific kinds of thinking to be taught as part of a comprehensive approach to teaching thinking.

Putting Humpty-Dumpty Back Together Again: The Importance of Emphasizing the Use of Thinking Skills in Complex Thinking

Certain approaches to teaching thinking emphasize a wide variety of very specific thinking skills. Other approaches emphasize teaching decision making and problem solving and teach broad patterns for organizing our thinking in making decisions and solving problems. Which of these approaches is preferable if we want to teach good thinking?

Combining teaching thinking skills with teaching strategies for problem solving and decision making

When we discussed the example of finding an alternative route to work, we stressed *both* the importance of specific thinking skills in doing the complex form of problem solving/decision making described and the need for organized and careful overall thinking in dealing with this issue. This means that if you are teaching specific thinking skills, such as distinguishing parts from wholes or reliable from unreliable sources of information, you should not simply teach these piecemeal. Instead, this should be combined with opportunities to help students use these skills in more complex thinking, such as making decisions or solving problems.

One high school program, for example, *combines* specific activities that focus just on such skills as predicting consequences (taught piecemeal) with activities that come later in the program in which students grapple with more complex issues. These issues might include draft resistance during the Vietnam War, the Watts riots in Los Angeles, and apartheid in South Africa; students would use the specific subskills they learned piecemeal earlier. This is a natural way of sequencing different levels of instruction in thinking. We are not sure it is any better, by the way, than sequencing instruction in thinking the other way around: Starting

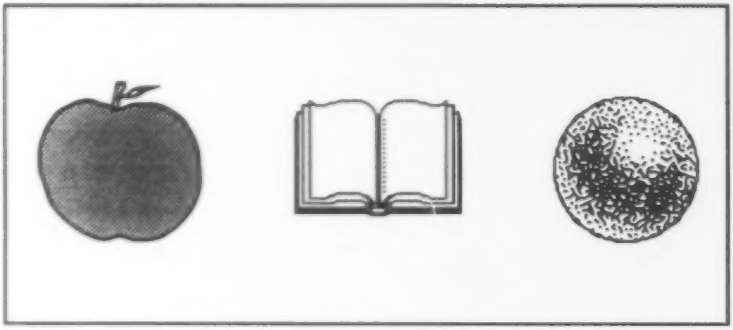
with teaching students broad organizing patterns for decision-making and problem-solving, and then fine-tuning these by excursions into instruction in thinking skills that are relevant in these processes.

On the next page is an organizing "map" of decision-making which attempts to locate typical uses for a number of the specific subskills of good thinking that teachers emphasize today in a decision-making context.

Embedding Thinking Skills Instruction in Decision-Making/Problem-Solving Frameworks

There is an interesting way to focus the attention of students on more holistic problems and issues and use this as a locus for teaching specific thinking skills. The decision-making flow chart in Figure 6. suggests this possibility. Consider the following typical activity designed to give students an initial exposure to teaching them how to *compare and contrast* things:

> Here are three objects. Make a list of similarities and differences between them.



This is typical of activities in programs and projects that take a piecemeal approach to the teaching of specific thinking skills. In such programs students are exposed to a multitude of such lessons, usually one after the other. Some such strategy for

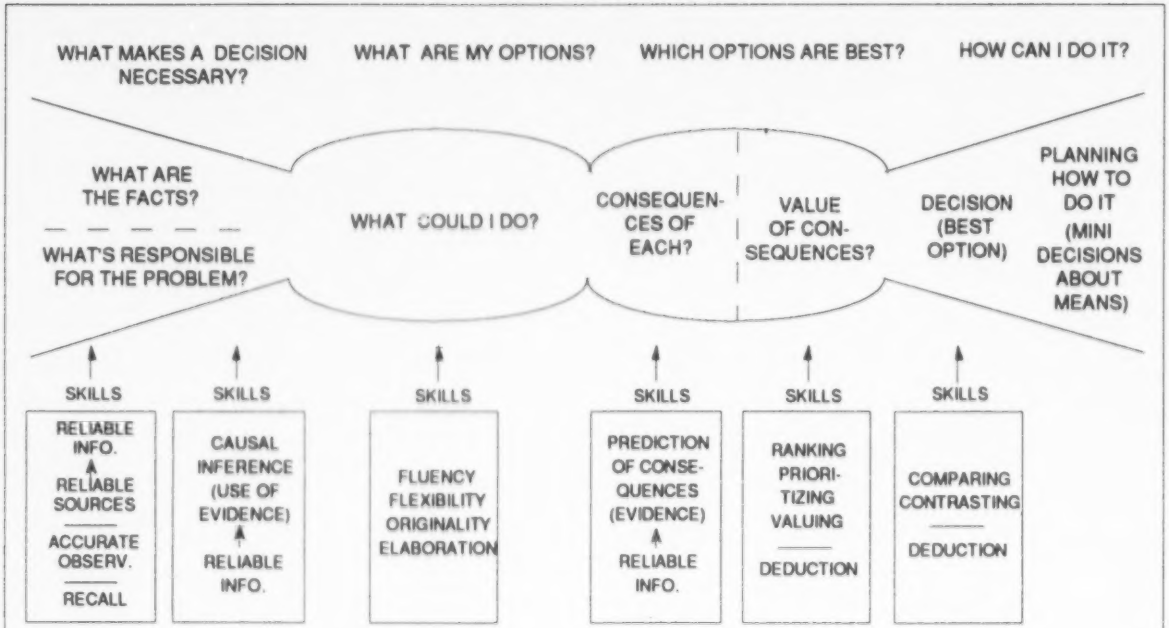


Figure 6. 2. Decision-making Map

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combining these lessons with broader problem-solving and decision-making activities as we map above will have to be used to help students see how these skills can be used. Now compare this with the following example in which instruction in the same thinking skill is *embedded* in a natural context in which we would normally use it. Notice how nothing seems to be lost, and much gained by this strategy. This lesson is from a fifth grade project on energy (Barman, *et al*, 1989, reprinted by permission, Addison-Wesley, Publishing Co., Menlo Park, CA.).

> People in the United States have been thinking about the best forms of energy to use so that we will have the energy we need and not pay a lot for it. People disagree about this, but everyone in the United States has a chance to think about it carefully themselves and express their views. You've been studying different forms of energy. Here's a chance to think about this question yourself.
>
> 1. First, make a list of things you would need to know about a type of energy that would help you decide whether it is a good source for a country to rely upon. Things on your list would be, for example, how easy it is to make the energy. What else would you add?
>
> 2. Pick three different sources of energy you've studied. Go back to the chapter on Energy Resources and get as much information as they give there to compare and contrast these different forms of energy with regard to the questions you have listed. Make a chart like the following with your question across the top and the energy forms down the side:

	How easy to make	Etc.		
Energy Type 1				
Energy Type 2				
Energy Type 3				

3. Put a plus next to the factors you think count in favor of choosing that type of energy, and a minus next to those that count against choosing it. Next, circle the factors you think are more important than the others. Explain why you put a plus, a minus, and/or a circle on these.

4. What would you pick as the energy we should rely on most? Why?

5. What important questions do you still have that are unanswered?

6. How could you get reliable information to answer these? List some reliable sources of information, and some that aren't. Why?

The opportunities for building on this lesson (fundamentally a compare-and-contrast lesson) to emphasize other skills that are important to use in this decision-making process, such as determining where one can get reliable information, should be obvious at this point to readers of this book. There even are opportunities for teachers to emphasize some thinking about values and value priorities built into this lesson in (3).

We know of one elementary school that builds its whole thinking skills program on this approach, using problem solving as the overarching framework (Dundas and Rowe, 1986).

>> *Concluding comments on combined approaches*

There is no research in the field today that indicates that any of these ways of combining thinking skills instruction with instruction in good decision making and problem solving are *prima facie* undesirable. We know of instructional circumstances in which students learn thinking skills well by focussing first on specific structured thinking skill activities with minimal content demands, then bridging them into the standard curriculum, and then working on more challenging problems in which a number of such skills are necessary to work through problems in a more systematic and thoughtful way. We also know of contexts in which students respond well to learning good thinking through the strategy of embedding described above. Our point here is that

it is important to emphasize *both* specific subskills *and* their use in decision making and problem solving in some way in teaching thinking. Problem-solving programs alone have as many limitations as teaching thinking skills alone. As of now, there is no definitive research that indicates more than this.

On the next page is a summary of the three different designs for teaching thinking that we have discussed in this chapter. This can serve as the basis for a comprehensive school system or classroom plans for teaching thinking.

Figure 6.3. Program Designs for Teaching Thinking

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CHAPTER SEVEN

HOW TEACHERS RELATE TO TEACHING THINKING: LESSON DESIGN AND INSTRUCTIONAL STRATEGIES

In chapters 4 and 5 we have described two ways that teaching thinking can become part of the instructional practices in a school or college. This can be accomplished by (1) adding teaching thinking on as a separate program, or (2) by infusing teaching thinking into the standard curriculum through restructuring the way traditional curricular content in subject-area instruction is used. The discussion revolved around the advantages and trade-offs in using one or another of these two approaches in the context of a typical school or college curriculum as well as the possibilities and opportunities in combining them. In passing, though, we also noted certain instructional design characteristics of a number of different examples from both separate programs and infused lessons.

We will now examine these instructional practices more systematically and in greater detail in order to show a range of options for the classroom teacher who wants to emphasize teaching thinking in his or her instruction. We will stress instructional techniques that are of *common* concern in both the classrooms of teachers using a special program to teach thinking and in those of teachers who have infused teaching for thinking into their regular subject-area instruction. As in the previous chapter, our purpose will be to set out a framework that practitioners can use to make wise choices in designing and selecting the ways and means of teaching thinking.

Promoting Active Thinking in the Classroom

We commented earlier that approaches to teaching thinking range from those that emphasize discrete skills taught with minimal content to those with a more holistic focus on developing informed positions on a variety of current issues. These differences are sometimes striking. We suggested in the last chapter that such divergent practices can complement each other within a broader framework for teaching thinking. There is one important feature of instructional design, however, that cuts across these diverse approaches. We wish to begin our discussion in this chapter with it. Quite simply, it involves getting students to *use* the sorts of thinking the program is concerned to help students improve.

Although this may seem obvious, the importance of *actively engaging* students in the thinking we are trying to teach them is something that has been stressed by most writers who have promoted teaching thinking. Many of us have a tendency to talk to students about thinking more often than to stimulate them to use it. In an important and influential pair of articles published in 1984 and 1985, Ronald Brandt and Arthur Costa distinguish between teaching *for*, *of*, and *about* thinking. They contrast both teaching *for* thinking and the teaching *of* thinking with teaching *about* thinking. Teaching about thinking involves focusing student attention on thinking as a subject matter and teaching about it. In and of itself, this makes students the passive recipients of information about the kind of thinking with which the teacher is concerned. For example, informing students that it is good to be able to break a whole up into parts, or that thinking about an issue like the arms race should involve considering a number of different points of view is teaching them something *about* thinking. Brandt and Costa maintain that this is not enough to help these students effectively learn *to do* these kinds of thinking. For this, it is essential to use classroom techniques which *actively engage* students in thinking, rather than just teaching about it.

This is a sound principle of educational practice in teaching thinking. Good thinking is something we actively do that in-

volves, among other things, the use of various organized forms of thought, including some very specific thinking skills. As in learning any skill, practice is essential. So our first pointer about choosing or designing a program for teaching thinking is that we make sure that the instruction is geared to students' *active engagement* in the thinking that is the goal of the program.

There are two key ingredients in successful efforts to engage students in active thinking:

1. the accessibility of adequate information students can use in their thinking;
2. the use of instructional techniques to prompt the sort of active thinking about this information that is the goal of the lesson.

We have already discussed the first in chapter 4. In the next two chapters, we will concentrate on the variety of strategies that can be used to do the second. Think once again about the commonalities in the relationships of the teachers to their students in the examples of teaching thinking we have discussed in this book so far. Can you see the strategies they use to prompt active thinking?

Teaching for Thinking and the Teaching of Thinking

The main contrasts in the field today between different programmatic approaches to teaching thinking are not, however, simply between programs that only teach about thinking and those that actively engage students in thinking. They are *amongst* programs that utilize instructional tactics to actively stimulate thinking on the part of students. The issue is basically that of *directedness*. The remaining pair of concepts from the Brandt-Costa triad—teaching *for* thinking and the teaching *of* thinking—represent aspects of instructional techniques that stimulate thinking with varying degrees of directedness.

Teaching *for* thinking involves creating a classroom climate that stimulates thinking. Many teachers do this as a matter of course. The following often-used techniques create a thinking en-

vironment in the classroom which stimulates students to engage actively in many forms of thought:

- allowing students to discuss things openly in the classroom, rather than to speak only when they think they have the right answer;
- asking thought provoking questions rather than just asking questions that prompt the recall of facts;
- providing more hands-on and exploratory activities rather than relying solely on paper-and-pencil tasks and worksheets; and
- bringing students problems to be solved rather than simply giving out information.

Typically and in themselves, however, these techniques are general in nature and do not focus on teaching any particular thinking skill or teaching students how better to solve problems.

The teaching *of* thinking, on the other hand, also involves techniques that stimulate active thinking, but does so in a more direct and explicit way. First, specific thinking goals, rather than thinking in general or undifferentiated thinking about a controversial issue, characterize the teaching *of* thinking. Thus, a teacher of thinking will aim, e.g., at helping students to compare and contrast well, as in the variety of lessons referred to in previous chapters. Or the teacher may help students distinguish between reliable and unreliable sources of information, as in the example from the infused history lesson.

Second, the techniques used to prompt the specific kind of thinking at which the lesson aims will usually serve in themselves *to direct the students through* that kind of thinking. Thus, when students are told to match up given shapes in a way that will yield another given figure, the instructions direct them step-by-step to put parts together to make a specific whole figure. In the Battle of Lexington lesson plan, the students are focused on important factors for making a critical judgment about eyewitness reliability. They are asked what they could find out about a specific eyewit-

ness and his report on the battle. This helps the students to decide whether or not to believe him, based on defensible criteria of the credibility of eyewitnesses.

Third, the instructor makes quite *explicit* the kind of thinking in which the students are being directed to engage actively. In the two cases above, this is done by using such key words or phrases as "parts" and "whole," and "factors that count towards the reliability of this eyewitness." To sum up these three points, the teaching *of* thinking involves instructional techniques that are highly directive in character, aim at *structuring* the students' thinking in very specific ways, and make explicit what this thinking involves.

In chapter 1 we indicated that there are now solid research findings that support the need for teaching students to organize and connect their ideas in various ways. We, therefore, endorse the idea that what teachers and administrators should look for in free-standing programs for teaching thinking and should design into efforts at infusion are more directive techniques. Such techniques should be aimed at helping the students do *structured* thinking of specific sorts. These would contrast with techniques which by and large only involve teaching *for* thinking.

We are not suggesting that the techniques used in teaching for thinking are unimportant. To the contrary, the degree to which a program or infused lesson also involves establishing a classroom atmosphere and climate that stimulates and encourages thinking *is* very important. This is true especially insofar as it encourages good thinking attitudes and dispositions. But in itself this is not enough. The program or classroom lesson designer's careful attention to the nature of the thinking skill that is the activity's goal is crucial in designing that activity. This holds true whether the activity is in a stand-alone program or an infused thinking skills project in a subject area like history or biology.

Skillful use of *questioning* directed at more than recall is crucial in efforts to teach thinking. Using the right sorts of questions can directly prompt active thinking. Asking "Why," "What...if,"

and "How" questions (rather than just asking "what" questions) and allowing students enough "wait-time" for thoughtful responses is a prime strategy in the thinking classroom.

The way teachers use such "higher-order" questioning often defines the extent to which the teaching *of* thinking is a goal. For example, many lessons that encourage good thinking in the classroom through the exploration of broad issues fall into the category of teaching for thinking. The teacher often practices questioning in these contexts, but the questions are simple and nondirective, such as "What do you think about that?" On the other hand, when questioning is used in the teaching of thinking, it is usually structured and directive, taking students through a process of thinking. In such cases a teacher may ask a *sequence* of very specific prompting questions. Remember the activities described in chapter 4 in which the first grade teacher asked students to think about what *could* have hit Chicken Little on the head, and then what *evidence* they might find to determine which of these is likely. Other uses of questioning techniques in the teaching of thinking will be discussed in the next section.

Directing Structured Thinking In the Classroom—Two Approaches

Specific classroom strategies for prompting explicit and structured thinking vary today in this field. This means that there are different ways of engaging in the teaching *of* thinking. Highly organized forms of *direct* teaching involve instructors giving students thinking strategies to use explicitly in the form of rules to follow in going through various *steps* in thinking. Sometimes charts exposing these steps are posted on a wall or written on a blackboard, and students are asked to follow them quite explicitly in doing the activity.

More *indirect* methods involve teachers interacting with students in a discussion. The teachers use prompting questions that focus student attention in an orderly fashion. Thereby they structure their thinking in accordance with the model for the thinking the teacher wants to promote. A less interactive form of indirect

instruction in teaching thinking involves relying on written activity sheets. These are composed of a series of written questions that guide students through a structured process of thinking. The comparing/contrasting lesson on different forms of energy that we reproduced in chapter 6 is part of a published elementary science program which relies heavily on these types of activity sheets.

To highlight this contrast in examples, we ask you to consider a teacher practicing the *direct* teaching of more effective decision-making by posting the chart (next page) on the wall of a fifth grade classroom. This serves to guide the students through structured decision making about the Boston Tea Party or one of Jack's decisions in *Jack and the Beanstalk*.

Another teacher may not rely on such a chart but may pose the problem of the Boston Tea Party and then first ask students what they think might be done. After allowing some open brainstorming, the teacher would ask them to select some of these options and think about their pros and cons. Or she might allow a more freewheeling discussion on these issues but stop students at certain points in the discussion and interject questions such as, "Dumping the tea is one option. Before you decide on this one, though, can you think of other options?"

There is no definitive research which indicates which of these specific classroom strategies is the best to use in general. One may fit some situations, the other, different situations. There are risks in each. The rigidity of the *direct* teaching of thinking may bore students or make teaching thinking into an unnecessarily routine activity . On the other hand, this approach has the advantage of making the structure of the thinking being advanced in the classroom quite explicit. As we shall see, that can enhance the learning of these forms of thinking. In contrast, there is a greater risk in *indirect* instruction that the thinking involved and its structure will be lost or escape the attention of the students. This is possible even though the instructor may involve students in highly structured forms of thought. Yet indirect instruction in thinking is, at the same time, more flexible and allows for more variation in

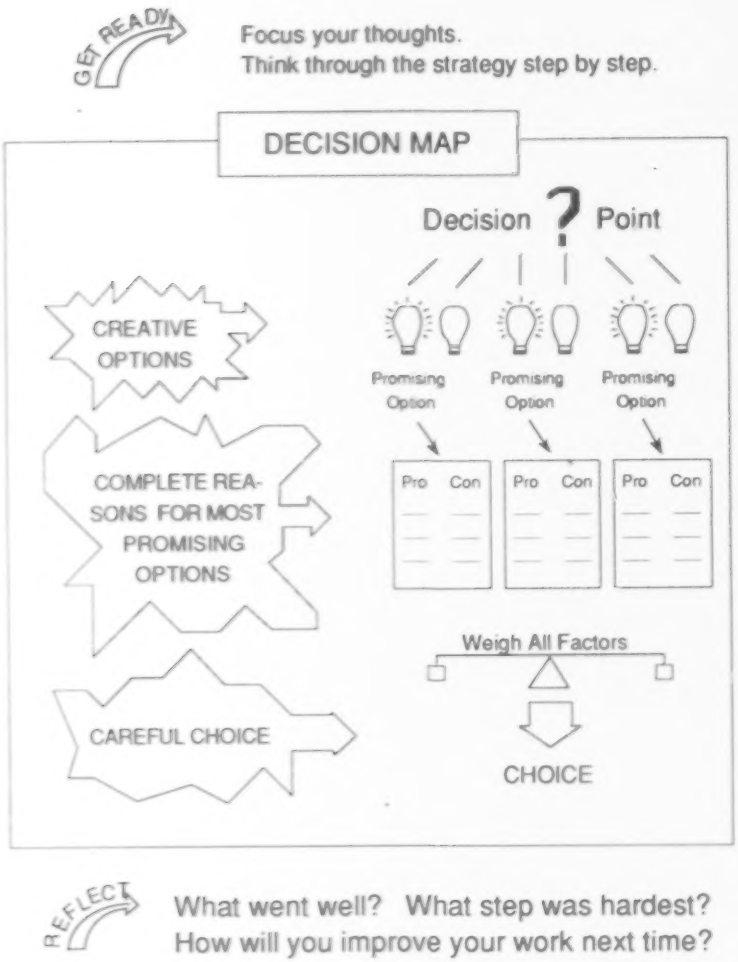

Figure 7.1. Decision Map

classroom interactions. We should add that while there are these risks, awareness of them can lead teachers to adopt various counter measures to provide more flexibility when direct methods are used, and more explicitness when the approach is indirect.

There is one important thing to note about *both* methods. Since the activities are so structured that they actually engage the students involved in the lesson in using the thinking skills to be taught, their structure should be based on a prior understanding of the *organized pattern* of thinking involved in the skill. Thus, both the chart in fig. 7.1 and the list of sequenced questions employed in more indirect methods are structured to reflect the lesson designer's conception of what is involved in doing good decision making. For this reason, it is important that lesson designers who are teaching thinking be absolutely clear about what is involved in the kind of thinking they want to teach their students. In the next chapter we will discuss how teachers of thinking can develop such understandings of the thinking skills they want to teach.

Our second pointer about choosing or designing a program for teaching thinking is that we should be sensitive to the degree to which instructional techniques are used to promote *explicit structured thinking* on the part of students. The contrast to keep in mind here is not between direct and indirect approaches to the teaching of thinking as illustrated in this section. Rather, it is between both of these and approaches that merely pose simple tasks or questions such as "What is the best thing to do," or "What is the explanation of this," or even "What do you think about this?" However open students may feel to responding to these questions, we run the risk that the thinking we want to teach may not be differentiated enough by students to be learned.

Teaching for Transfer—The Use of Varied Practice

One important dimension of the instructional strategies that we have stressed is the degree to which the teacher prompts students to structure and articulate their thinking. There is a second dimension with which to be concerned in reflecting on program design.

It is related to student *assimilation and transfer* of forms of thinking outside their classroom. We need to be concerned with the instructional strategies involved in this process.

As we indicated in chapter 2, transfer is a matter that is of major concern in the critical thinking field today, and much has been written about it. Research has tended to show that, while some approaches to teaching thinking may stimulate good thinking in the classroom, there is little or no transfer to learning in other classes or to everyday thinking patterns. Students simply do not do the same sort of thinking outside of the particular contexts of instruction, even in situations which clearly call for it. To counter this, a number of techniques in teaching thinking have been introduced to teach *directly* for transfer.

These enhancement techniques are not complex or difficult to introduce. For example, some teachers come back again and again to certain thinking skills issues that are applicable in different classroom topics. We already have indicated how Kevin O'Reilly, for example, asks his students to think again about the reliability of eyewitnesses in considering different accounts of conditions in the South under the institution of slavery. *Varied practice* with the same skill or thinking activity supplements the initial exercise that the students perform. The emphasis on varied practice is based on the recognition—incorporated into the teaching of any skill—that one attempt, even if successful, rarely suffices for learning a skill.

This need for repeated practice is manifested in various published thinking skills lessons as well. In the comparing and contrasting lesson on energy we discussed in chapter 6, another example for the use of the skill is explicitly included in a section of the lesson called "Using the Skill" (Barman *et al*, 1989):

> *Using the Skill*
>
> Think about a number of different things you could get for a sister, brother, or friend for a birthday. Use your chart to compare and contrast these so that you can make a careful and good choice.

Here is one written into a science lesson to follow up a detailed lesson on causal explanation (Barman *et al*, 1989).

> Scientists are concerned about some of the earth's animals. The populations of these animals are becoming so small that the animals might become extinct. What are some things that could cause this effect? Some endangered species are tigers, orangutans, whales, sea otters, and whooping cranes. Pick one of these and see what evidence you can find to help you decide which possible cause is the most likely one.

Obviously these two techniques—additional practice using the same skill right after the initial lesson and such practice recurring at greater intervals from it—can both be used. Our third pointer about the instructional design of lessons in teaching thinking is simply—the more transfer is reinforced, the better.

In looking over published thinking-skills programs, it is not difficult to notice the presence or absence of teaching for transfer. If this strategy is not incorporated into a program, teachers should actively supplement what is there with such repeated practice.

Two additional matters related to technique in teaching for transfer are worth mentioning here. The first has to do with the kinds of examples used and the scope of these transfer activities, and the second, with the *structure* of additional activities that call for using the same skill.

What kinds of examples should be used in teaching for transfer?

The first variation involves the *kinds* of examples used as follow-ups. Obviously, the more varied the examples, the broader the field of application to which students will become accustomed. In the biology program mentioned above, for example, there are other biology examples used as follow-up activities for more practice in a particular skill. The example about endangered species calling for the use of causal reasoning illustrates this. However, there also are nonscience, real life examples. The birthday gift example quoted illustrates the latter. Time constraints in the classroom, of course, limit the degree to which a real multi-

plicity of varied follow-up examples can be introduced to supplement any particular well-articulated thinking skill lesson.

Teaching thinking skills *across the curriculum*, as described in chapter 4, has the potential to overcome the limitations created by such time constraints. A well-coordinated effort of this sort based on the same conceptual framework of thinking skills and activities can provide rich and varied reinforcement of instruction in important thinking skills across and in a variety of different fields of study. Imagine the use of causal reasoning that is built into a first grade lesson on what caused the bump on Chicken Little's head. Then envision it reinforced in the experience of a student whose fifth grade teacher explores questions about the causes of the extinction of the dinosaurs with them. Similarly, the ninth grade history teacher explores issues about what caused the depression, using the same thinking structure for causal explanation. And the students' tenth grade English teacher has them think through the motivation that caused some of the characters to act as they did in *Huckleberry Finn*! Such an across-the-curriculum reinforcement of the use of the same thinking skill depends on these activities *not* just involving the use of the same thinking skill word. The *structure and organization* of the thinking skill being taught must be the same.

Many schools are currently striving for this across-the-curriculum reinforcement through coordinated infusion projects, as are a number of colleges. They are abandoning the idea that we can rely solely on one critical thinking course to help students be better thinkers.

How structured should additional examples be in teaching for transfer?

The prime motivation in introducing more practice with the same skill is to help students become more accustomed to using a specific thinking skill in contexts different from those in which the skill was learned. A second reason exists for introducing additional examples for student practice. It is to impart *control* of the

thinking lesson in the classroom more and more into the hands of the students.

In initial lessons that involve the teaching of thinking, the thinking that students do is prompted by the teacher through specific directed questions. But we want students to do this kind of thinking when teachers are not there to prompt them. Thus, some lesson designers deliberately ease up on the structuring of follow-up examples and provide only motivational cues so that students will provide their own structuring. After taking students through a highly structured activity regarding the reliability of eyewitness reports of a historical incident, a teacher might give them other reports and simply ask them to assess their reliability. The students then should provide and use the structure to which the teacher has introduced them in the more articulated preceding example. In later examples such a teacher may not even use the cue word "reliability" but may simply say, "Here are some eyewitness accounts." Usually an intermediate step in this process involves students in articulating this structure by referring to a chart like that in Figure 7.1, or through some guided metacognitive reflection after the initial activity.

Once again, we urge that teachers be sensitive to these subtleties in using a thinking skills program or in developing their own infused lessons. If such techniques are not present in a program, you should try to work them in yourself when you use it.

The Use of Metacognition in Teaching Thinking

Varied practice in itself is often not the only ingredient in lessons designed to teach thinking that is introduced to supplement the active use of thinking skills. How the students engage in the varied practice often presupposes another important component of these lessons — bringing students to a *metacognitive* awareness of the thinking processes that they are being taught to use. For example, the teacher can ask students to deliberately *extend* the kind of thinking they have just done to these new examples. This suggests that they know what this kind of thinking is and are now being asked to deliberately use it again.

As we found in the lessons described in Chapter 4, various techniques can be used to prompt students' metacognition. In the next three sections we will explore different types of metacognition, why it is important to engage in these, and how teachers can help their students learn to engage in them well.

In chapter 3 we pointed out that metacognition usually involves shifting our attention away from what it is we are thinking about and focusing it on our own thinking. Suppose I am trying to decide whether to buy a new car. In metacognition, I would shift my attention from the car to how I am making the decision about whether to buy it.

The ultimate goal of emphasizing metacognition in teaching thinking, as we have remarked, is to help students monitor and direct their own thinking by a deliberate, conscious effort. Suppose, for example, that I realize that I am careless in making decisions. I might find that in the past I have usually taken the first thing that came into my mind and pursued it. Often, I found that I had made the wrong decision. After reflection, I realize that if I consider a number of alternatives first, I will probably make a better decision. The next time I make a decision I may say to myself: "I should consider a number of alternatives before I decide what to do." Or I may realize that I rarely try to gather more relevant information than what I have at the moment. However, I also realize that the more relevant information I have the better my chances of making a good decision. I may then make an effort to look for more information. When I direct my thinking in this way, I am practicing metacognition at its best.

There are issues about the degree to which students at different grade and ability levels can realistically manage such thinking. In the primary grades (grades K–2), for example, the need for extended attention to a task (with which many students have difficulty) and the conceptual sophistication necessary for this type of self-direction often make it unrealistic to attempt such sophisticated forms of self-direction with students. These types of thinking should be considered as goals of thinking skills instruction. While

they should be incorporated as much as possible, no program or infusion design should be faulted because it does not incorporate them in every lesson.

Still, one should look for regular appearances of *some form* of metacognitive activities in well-designed programs and infusion projects. There are a variety of practices that have been introduced to help *accustom* students to thinking about their thinking, and some of these are perfectly appropriate even in the primary grades. The capabilities of students to monitor and direct their thinking can be built up by stressing in a systematic way one or another component in metacognition.

Three Levels of Metacognitive Instruction

The distinction we introduced in chapter 3 between three gradations of awareness of our own thinking can serve as a framework to classify what may seem like quite divergent practices in the field today. If you remember, we spoke of tacit uses, which we contrasted with aware uses, strategic uses, and reflective uses of a form of thinking.

A tacit use of a form of thinking involves no specific level of awareness of the sort of thinking in which we are engaging when we think about something. If I am so engrossed about which car to buy and then make a decision, I may not think at all about the fact that I am making a decision or how I make it. Indeed, much thinking goes on in this way. Not that it is too difficult to stand back and attend to what we are doing—we simply do not do this much of the time. In this case we are only tacitly aware of how we are making a decision.

Aware uses of thinking skills: thinking about what the thinking we do is called

On the other hand, there is a minimal sort of awareness we often have about our thinking. I may identify what I am doing as "making a decision," "predicting," or "comparing and contrasting two things." This is what we call an aware use of a form of thinking. At its roots, it involves simply *classifying* our thinking.

Many common practices in thinking skills instruction are directed at this level of awareness. Sometimes in the introduction to a thinking skill lesson students will be told, for example, "Today we are going to learn about *predicting*." Sometimes such pronouncements seem too formal, and terms like "predict" are used in more natural contexts, as in "What effects would you predict as a result of...?" In either case the goal is to make students aware of the type of thinking they are doing.

Here is a more elaborate version from a published program of the first type of practice mentioned above. In this example students are not just introduced to what word is used to identify this type of thinking. The author elaborates upon the identity and importance of the type of thinking (Barman, *et al*, 1989).

> *Predicting*
>
> What are some things you are sure you will do tomorrow? When you think something will happen before it actually happens, you are predicting. Predictions are very important to us. If you are going outside and it is sunny, you may predict it is not going to rain. Then you can plan what to wear.

Except in very early childhood education, it is insufficient merely to help students become aware of the classification of their types of thinking. This does not tap the full potential that students have for metacognition. Nor does it greatly contribute towards the goals of reflective thinking we outlined above. This is true even if the thinking skill which is identified is elaborated in examples like the above. Teachers should be sensitive to this point and introduce more challenging forms of metacognition if a program does not provide these or if they are developing their own lessons. More challenging forms of metacognition will involve students in *strategic* and *reflective* uses of thinking skills.

Strategic uses of thinking skills: thinking according to a plan

When we discussed examples of infusion,we pointed out that good thinking skills teachers prompt their students to explicitly

apply the kind of thinking to which they have just been introduced to additional examples. This enables the students to become accustomed to doing this kind of thinking and it facilitates transfer. When this involves students in going through an articulated plan for their thinking—perhaps even going through a series of steps—they are engaging in a *strategic* use of a thinking skill.

One good example of this is in the *direct* teaching of thinking, as we described it earlier. Students are given a thinking "map" to follow like the one reproduced earlier. A history teacher sometimes posts the following boxed item on his wall when he introduces students to thinking about the reliability of sources of information. It contains a series of questions—together with an acronym that serves to remind students of this strategy when the chart is not there—to ask about the author and the author's report of a historical incident (O'Reilly, 1983).

P	Primary or secondary?
R	Reason to distort?
O	Other evidence supporting this sentence?
P	Private or public?

Using this is relatively easy in many of the cases when information is available to answer these questions. In cases in which time is a factor, the teacher can provide such information so that students can concentrate on practice at using this strategy without becoming involved in complicated research. Answers to these questions generate information on the basis of which an initial judgment of reliability and accuracy can be made. Teachers might caution their students that these judgments should not be taken as definitive and that other factors may have to be considered.

This is a more sophisticated way of being aware of our thinking; it goes beyond simply identifying it as thinking of a certain type. Our awareness is more articulated, and the thinking is broken up and ordered in a certain way, dictated by the conscious

plan we have for thinking. Indeed, this may make our thinking *better* thinking. We might attend to certain things, such as the PROP factors in following this strategy, to which we never would have attended. And that may enhance our judgment of reliability.

But strategic thinking, as represented by this example, leaves much to be desired. It *can* be very mechanical and routine. Moreover, there is a danger that the process may become rigid. Even if students are told that judgments should not be taken as definitive and that other factors need to be considered, they may limit themselves to the bare essentials such as the PROP formula. So while this brings us closer to the kind of reflective thinking we described above, it still does not allow students to reach their full potential in exercising metacognitive control of their own thinking.

Reflective thinking: learning to monitor our thinking

There are two crucial ingredients in reflective thinking: monitoring, or becoming aware of how we *do* think; and directing our thinking according to some well thought-out ideas about how we *should* think. Both of these are the objects of classroom practices. These practices are also directed at helping students become accustomed to thinking about their thinking. In this case, their thinking about thinking differs from the uses practiced in aware and strategic uses of thinking skills.

There are some characteristic practices that teachers use that are designed to help students gain facility at *describing how they are thinking*. For example, students are sometimes *retrospectively* asked to describe what they did in thinking through a particular problem or issue after they complete it. Or a teacher may ask students to list the strengths and weaknesses they detected in various arguments put forward to support a position. When students do this they are giving a retrospective record of the standards they used to make these judgments. Below is a more structured activity from a fifth-grade science program. It focuses on students attending retrospectively to the steps they actually went through in making predictions that they considered likely with regard to the weather (Barman, *et al*, 1989).

Thinking about Thinking

Here are different things that were involved in your thinking about the weather:

making a judgment of how probable your prediction was

thinking about what the weather might be like

gathering evidence about the atmospheric conditions

thinking about what evidence you could get

When you thought about the weather you did these step by step, but not in the order above. Fill out the chart below for the right order.

1. _____
2. _____
3. _____
4. _____

Some instructors use a certain type of classroom organization to bring out the strategies students are using in their thinking. Students are organized in pairs and given a problem. While one of the students "thinks out loud" how to solve the problem, the other records the thinking strategies being used. Students from the middle elementary grades on up are perfectly capable of either of these more detailed forms of metacognition directed at helping them to *monitor* their thinking.

Thinking about how we should conduct our thinking

A final set of practices in the field today focuses on a crucial *prescriptive* ingredient in reflective thinking. This involves thinking about effective ways of solving problems, making decisions, and engaging in any number of other thinking activities. Determining the *best standards* to use in making good critical judgments is sometimes included in this. Is it better to consider a number of options or just settle on one in making a decision? Does having a vested interest in something count in favor of or against the reliability of someone's report? In trying to answer

these questions, students are thinking about how they *should* think, not just how they *do* think.

Here is a continuation of the activity about prediction that we just reproduced in which the attention of students is shifted away from how they did think to whether this is a good way to think (Barman, *et al*, 1989). They are asked:

> Do you think this is a good way to make predictions? Why?

A variation on this idea appears in the "reflect" section of the decision-making chart in Figure 7.1. There students assess their thinking and consider how they can improve it.

A more interactive practice is to ask students who have just reflected on how they went about solving certain problems to compare the strategies they used and discuss which worked better. Open discussion of this question in the classroom has the advantage of exposing students to a number of different strategies for thinking. This can open them to new ways of solving problems that they might otherwise not have considered. Studying characteristic strategies that inventors or great thinkers used and then discussing whether these are good strategies for others to use can enhance this process.

One important strategy appears in some of the published thinking skills material. There students are given a chance to think about and test out whether certain rules of logic are correct. For example, elementary school students read along in a children's novel and follow two characters who think about whether, if they accept that all apples are fruits, they are also committed to "All fruits are apples." Using simple examples like these to test their ideas, they develop the principle that "All A's are B's" does not imply "All B's are A's." This is a standard rule of logic.

The children who read this novel are supposed to discover, along with the characters in the novel, that this rule of logic is a good one to guide our thinking. Then, a friend of one of the children's mother comes along and says that she thinks that all people who want to help the poor are communists because she thinks that

all communists want to help the poor. The children point out to her that she is making a mistake in her thinking. Such techniques are well worth noting for their attention to a spirit of critical enquiry that makes even the principles of good thinking fair game for critical reflection (Lipman, 1976).

It is through combining these two ingredients—monitoring and directing our thinking—that the type of metacognitive guidance of our thinking with which we started our discussion comes about. If you are choosing or designing a program for teaching thinking, it will be important to keep in mind the relationship between the disparate metacognitive practices that you will find in these programs and this goal. A final pointer about the instructional design of lessons for thinking is to be sure that sufficient metacognitive activities are built into these lessons to facilitate students learning to monitor and direct their own thinking.

Summary of Different Approaches To Teaching Metacognition

These different approaches to introducing metacognition into instruction are summarized in the table on page 187.

While we feel that no one of these strategies is better in general than any other, some are certainly better suited for some instructional contexts than others. We do want to caution, however, that the most common form of metacognitive activity introduced into thinking skills instruction—simply introducing students to how to classify their thinking—should be supplemented by some of the strategies that help students better learn to monitor and direct their thinking. At least these should be included at some appropriate times in thinking skills instruction.

Earlier we agreed with the Brandt-Costa position that teaching *about* thinking alone is insufficient for good instruction in thinking. We want to stress the word "alone" here. In discussing metacognitive strategies we have, in a sense, been discussing ways to teach students *about* thinking. These strategies are *invaluable* in the teaching of thinking. The degree to which teaching about thinking is integrated into an instructional program should

be something teachers look at very carefully in assessing or designing such programs.

Pointers about Lesson Design and Instructional Strategies in Teaching Thinking

In the course of this discussion we have listed four pointers about instructional techniques in teaching thinking. These should help as focal points to consider in making choices about which approach to teaching thinking you want to use. It is worth listing these all together here:

1. Make sure that the instruction is geared to students' active involvement in the kinds of thinking the program is designed to teach.
2. Consider the degree to which the instructional strategies present explicit structured thinking to the students.
3. Attend to how many varied opportunities students are given to practice the types of thinking taught.
4. Be sure there are sufficient metacognitive activities built into the teaching of thinking to facilitate students' learning to monitor and direct their own thinking.

Table 7.1. Approaches to Introducing Metacognition Instruction

I. *Prompting Aware Uses of Thinking Skills* (Using thinking terms—e.g., "predicting," "uncovering assumptions," etc.—to mark the presence of these thinking activities.)

Strategies:

A. Announcing: "Today we are going to learn about predicting."
B. Using these words naturally: "What effects would you predict as a result of...."

II. *Prompting Strategic Uses of Thinking Skills* (Providing a list of components or a series of steps for students to follow in doing a certain type of thinking.)

Strategies

A. Posting on the schoolroom wall or blackboard a list of steps to follow before the thinking activity starts.
B. Verbal prompting of students to go through a series of steps in their thinking.

III. *Prompting Reflective Uses of Thinking Skills* (helping students monitor their thinking by describing it, helping students reflect on effective ways of doing this type of thinking, and then asking them to direct their thinking accordingly)

Strategies

Monitoring

A. Ask students to describe retrospectively what they did in thinking about a particular issue or problem
B. Have students think out loud while another student records the thinking processes going on

Prescribing

Asking students

A. to develop rules for good thinking
B. to recommend to others ways to think
C. to plan a thinking project
D. to correct ineffective thinking

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CHAPTER EIGHT

SUPPORT SYSTEMS FOR TEACHERS AND SCHOOLS TO TEACH THINKING EFFECTIVELY

At present there are no significant provisions made in professional preservice teacher education programs to help teachers become good teachers of thinking. By and large these programs tend to stress very traditional modes of instruction which emphasize factual knowledge. Moreover, in those preservice programs in which prospective teachers must major in a specific field in the arts and sciences, or take a number of required arts and sciences courses, courses that incorporate teaching for thinking as we have described it in this handbook are not usually part of the curriculum. Hence, there is no direct instruction available to teachers on the basis of which they can begin to develop the professional expertise needed to do such teaching well. The instructors who are their models in the arts and sciences courses (which are the fields in which most teachers will be teaching in their professional careers) tend, by and large, not to teach thinking explicitly. We are aware of efforts being made to reverse both of these strong traditions in higher education, but until these efforts bear fruit, this comment should be taken as an unfortunate description of the way things are.

This means that other devices must be relied upon to help teachers develop this professional expertise. Fortunately, there are some traditional vehicles which are being utilized in the field today, like written teacher's manuals, as well as structures like in-service programming. And there are some more recent innovations, like the use of peer-coaching, that are being applied in the

teaching thinking field to serve this purpose as well. In this chapter, we will discuss some of the virtues and some of the limitations of these support systems both in helping teachers to use predeveloped programs well or to develop their own programs.

Teacher's Manuals as Guides to Teaching Thinking

If a published program is to be used directly with students and is developed by someone other than the teacher who is to use it, some guidance for the teacher is usually necessary. This applies both to separate programs designed to be added to the curriculum and to programs to be infused into regular classes in the curriculum. A very traditional means to achieve this is through a specially designed manual for teachers. There is, indeed, a sense in which parts of this very book that you are reading fall into this traditional category of support systems for teachers.

But there are manuals and there are manuals. Some are general in character; others are in the form of a running commentary on specific activities. Some are highly prescriptive; others only provide suggestions and are written with greater flexibility. Some are published separately from the materials; others, like teacher's editions of many text books, juxtapose a text for teachers with the material to be taught. Are all of these equally viable?

By its very nature, teaching thinking moves teachers away from relying on didactic methods of instruction like lecturing and involves them in more interaction with students. Because of this, a close commentary for teachers in which possible reactions by students are commented upon and in which suggestions are made about how to respond is preferable to teacher's guides that are general in character and detach their suggestions from specific activities utilized in the program. At the same time, we feel that some general comments *are* necessary about thinking, about the particular approach used, and about some of the more common features of teaching thinking that may permeate the program. This is primarily because teachers will not have been exposed to these precepts in their pre-service education.

On the next page is an example of a teacher's edition page from the elementary science program from which we have included sample lesson material (Barman, et al, 1989, reprinted by permission of Addison Wesley Publishing Co.). Notice that there is an attempt to inform teachers about the thinking skill, about why it is important, and about some general ways of teaching it. It also provides commentary on the specific lesson.

This approach to written support material for teachers to accompany published material students will be using, accompanied by general comments about teaching thinking directed at teachers, is one we recommend as more accessible than others. In cases in which only some of these components are present (e.g., a commentary but no general perspective-setting comments on teaching thinking), what is in the support material should be supplemented by one or two of the many articles that are available today on teaching thinking.

Quality material to support efforts by teachers to teach thinking need not be—and in fact is not—restricted to back-up material to already published lessons or programs for students. More adventurous attempts are being made to provide written guidance to enable teachers to create their own thinking skills lessons. The *Tactics for Teaching Thinking* project (Marzano, 1987), produced by one of the regional educational laboratories, is an example of such a written support program for teachers. Another is in a more experimental stage and is called *Connections* (Mirman & Tishman, 1988). It is produced by another regional educational laboratory and focuses on infused lessons.

Finally, a university-based center has produced a set of handbooks on remodeling lessons in language arts and social studies for grades K–3 and 4–6 that similarly provides guidelines and plenty of examples for infusing critical thinking into these subject areas (Paul, et al, 1987).

Written support material of both these sorts for teachers has the potential of reaching a huge audience in the educational community. Still, there are drawbacks to relying on this type of support material alone. It is often claimed in educational circles that many teachers don't read such written support materials. We do not know whether

Accurate Observations

Accurate observations result from the use of one or more of the senses, either unaided or aided by instruments, to obtain information. The reliability of observations varies with factors such as the experience and attentiveness of the observer, as well as with the quality of any instruments used in making observations. In order to judge the reliability of observations, information should be gathered about the observer and the circumstances under which the observations were made. Then an assessment should be made whether the information would count in favor of or detract from the accuracy and reliability of the observations. Finally, the information can be evaluated to determine its accuracy.

Along with gathering information from reliable sources, the critical thinking skill of accurate observations is the source of the basic data on which all scientific knowledge is founded. It is crucial in gathering information from observations that students learn early to discriminate between accurate and inaccurate observations.

Thinking Critically

Accurate Observation

When people make observations, as we do when we collect information, their accounts of those observations are dependent on several factors—such as the observer's experience, knowledge, point of view, distance from the object being observed, and the quality of the instruments used, if any.

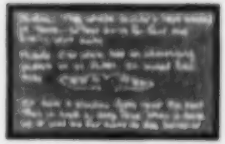
Accurate observation is a very important thinking skill in science. For example, Dr. Jane Goodall spent years observing chimpanzees in Africa. She had daily contact with the chimpanzees. She named them, kept track, and observed them very carefully and closely. She learned a lot of things we did not know about chimpanzees. The articles and books she wrote educated other people. They are good models of accurate observation that have taught people a lot about animal behavior.

1 Practicing the Skill

A class went on a whale watch as part of their study of animal behavior. They were told to keep a journal. They noted each whale they saw and noted what they observed.

The students saw a total of seven whales. Three humpback whales came very close to the boat. The students enjoyed the whales' antics and wrote paragraphs in their journals as the whales dove, breached, and swam around.

When the students returned to their classroom, they organized their notes and shared their observations. They wrote their notes about one whale's behavior on the chalkboard.



Do you wonder about the accuracy of anything these students observed? What? What questions would you want to ask each student to help you decide if their observations are accurate? If you could not ask any questions, how might you go about determining how accurate these observations are?

2 Thinking About Thinking

Describe your thinking as you came up with your list of questions for each student. Make a list of rules someone could use to judge whether an observation is accurate.

3 Using the Skill

Find a newspaper or magazine article that quotes someone's observation of a crime or an accident. Use your rules from above to judge how accurate the observations are.

Accurate Observations (cont.)

In the critical thinking activity on these pages, students will learn about factors they should take into account when determining if observations are accurate. Some of these factors are the observer's experience, knowledge, point of view, distance from what is being observed, and the quality of instruments used (if any). None of these factors proves that the observations are accurate or inaccurate, but the factors count in favor of or against accuracy.

Students are given a list of observations and asked to determine whether each observation is accurate. They should also consider other ways to go about determining the accuracy of the observations. Students are asked to make a list of rules someone could use to judge if an observation is accurate. Finally, they are given the opportunity to use their list of rules to help determine whether or not a magazine or newspaper article has accurate observations.

THINKING CRITICALLY

Practicing the Skill

In this activity, students should think about two important things: the descriptions of the whales' behavior and how carefully the observations were recorded. The anthropomorphic description of the whales should cause students to wonder about the accuracy of the description. For example, claiming that the whale couldn't have wanted the class there is problematic. Joshua has no way of knowing what the whale wants. Joshua's sketchy descriptions indicate speculation and little care in attending to details. Although Michele's report is slightly more detailed than Joshua's, her account is still vague. The only thing she mentions that agrees with Joshua's account is that the whale dove a number of times.

On the other hand, that Michele did not attempt to observe the whales when they were too far away to see clearly suggests careful attention to the limitations of her perspective. Use of words like *flow* also suggests some expertise about whales.

Encourage students to think about the conditions of the observers at the time the observations were made. Here are some questions the students might ask themselves to help decide if the observations are accurate:

1. Were the observers in clear view of the whales, or was something obscuring their view?
2. Did the observers use any instruments? If so, how good were they?
3. How long after they observed the whales did the observers complete their notes?

If students are unable to answer all of the questions they list, they might check for accuracy by finding out if any other observers could substantiate the descriptions. Finding corroborating evidence is important in assessing accuracy of observations.

Thinking About Thinking

When students describe their thinking about how they came up with a set of questions, to determine accuracy they should reflect on how they actually decided what relevant information to gather and on what specific questions they decided to ask to gather their information. Some possible student descriptions might include comments such as: "I thought about things that could go wrong with the observations, like not having your glasses on and made a list of these things. Then I made a list of informational questions based on this list. Or: "I thought about what I would do to gain the most accurate observations I could make, like bringing binoculars and making sure I was in a good position for observing on the deck. Then I made up a list of questions asking each observer if they did these things."

The rules the students formulate should not factors they think people should consider in assessing information. Factors include the observer's experience, knowledge, point of view, distance from the object being observed, and the quality of instruments used.

Using the Skill

To help students develop the skill of finding and making accurate observations in other aspects of life besides science, they are asked to use the set of rules they developed in Thinking About Thinking to judge how accurate are the observations of a crime or accident described in a magazine or newspaper. If students have trouble finding articles, you may want to collect some and bring them to school for use with this activity. Articles with more than one observational report will provide rich examples for students to judge.

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this is true in general, and if so, to what extent. But we do know that a number of written programs in the past have been set aside by teachers and schools. This is due to the apparent failure of what is written to reach teachers so that they were able to manage the program well and were comfortable teaching it. At the very least this suggests that those writing such commentaries should do so with great care, and that this type of support system should not be the sole form of support given to teachers in teaching thinking.

In-service Teacher-training and Staff-development Support Systems

A number of published programs on thinking do not rely solely on written teacher support materials. Sometimes special workshops are led by specialists from the program to help teachers learn how to use the materials well in teaching thinking. Independently of any connection with published material for students in the field, many schools and school systems have also availed themselves of traditional in-service workshops to help teachers, using their ordinary materials, develop the professional expertise they need to teach thinking.

Such workshops can be incorporated into the teachers' regular schedules by using the half and full release days built into school time that are provided as normal professional opportunities. Alternatively, such opportunities could be provided after school or on Saturdays. A variant of this is enrollment in off-site workshops. These may be either at the headquarters of a specific program or at one of the numerous conferences on teaching thinking that are held both regionally or nationally during the school year or in the summer. There are also the handful of graduate programs for teachers at various universities and colleges that emphasize teaching thinking. This would include the program that sponsored the development of this book series.

If there is one loud and clear message that grows out of our experiences with these forums for supporting teachers in teaching thinking, it is that there is no "quick fix." Individual presentations

and workshops can at best be initial awareness sessions for teachers. Even if lesson plans are handed out at these sessions, or if teachers take back whole programs with them, we should not labor under the misapprehension that anything more than a mechanical application of these lessons in the classroom can, in general, occur. More ongoing support structures are needed. This is because the process of teaching thinking involves focusing explicitly on thinking skills and processes—things on which teachers are not used to focusing. It can also be attributed to the need for a more open and interactive style of teaching then teachers are usually trained in or experience in their own education. (We are not saying here, of course, that there are not teachers whose natural bent is to teach for thinking and who do not need extensive support to do so.)

Some predeveloped thinking skills programs provide such ongoing support, and some staff development projects are indeed set up in this way. For more in-depth specialization in teaching thinking, the certificate or graduate degree programs available in this field should be considered.

There are two kinds of ongoing teacher oriented programs utilized in helping teachers develop expertise in teaching thinking:

- *teacher training* workshops, in which teachers are trained to use specific materials to teach thinking, and
- *staff-development* programs, in which some or most of the time is spent helping teachers gain the expertise to develop and use their own materials to teach thinking. The latter includes the various infusion projects that schools have undertaken.

We have little to say about training programs that are aimed at training teachers to use specific materials to teach thinking. These can be very effective, but, in general, they should be recognized for what they are: training programs in the use of specific materials. They are not empowerment projects aimed at putting teachers more in charge of their own thinking-skills lesson design and

development. The danger of such training programs that are on the short end of the scale is, of course, that they can lead to a very routine use of the materials and little change in overall teaching style. But this need not be the case. If you are involved in a specific program and want something more than routine training in using these materials, you should go into that program with this potential limitation in mind. If the program *is* narrow in scope, you can always supplement it with something that does aim more at teacher empowerment and is not necessarily tied to the specific program you are working from.

Full-blown, on-going *staff development* programs—programs aimed in one way or another at teacher empowerment—are a different matter. They are run quite frequently in schools and school systems that have made a commitment of bringing teaching for thinking into the classroom, at least in large part, through teacher-constructed materials. These vary in length from once every week or every other week for as little as three months to three to five years. Those that take place on-site are either after school or during the school day when substitutes are hired to release groups of teachers to work on the project.

Obviously the content and conduct of these courses can vary considerably. It is not our intention, however, to review these variations here. We do want to suggest, though, that whatever the focus, effective staff development programs in teaching thinking should include at least the following three components:

1. some study of forms of thinking and their importance in academic work and in our lives;
2. practice doing the kind of thinking that is the specific focus of the project; and
3. detailed attention to how best to teach this to students.

These should be both experiential and conceptual.

It is *especially* important that attention to specifics in lessons or activities for students be involved in these staff-development projects. In programs in which "bridging" is promoted, or in infusion projects, time should be set aside for actual lesson development. Case studies of other teachers implementing the approach should also be used, where possible, to stimulate such lesson development. These can be in the form, for example, of lessons that other teachers have developed themselves in infusion projects, or studies of teachers using the materials in predeveloped programs. Internships or apprenticeships with such teachers is better still, but obviously not easy to set up in many communities. Finally, we feel that it is important to include time in such programs for "debriefing" the teachers who have tried out in their own classroom the approaches promoted in the program.

Using Consultants as Support Staff for Teachers in Teaching Thinking

There are many qualified consultants in the country to help set up and run teaching thinking programs. At the risk of belaboring the obvious, however, we would caution that you make sure that a consultant in whom you might be interested is qualified. If a person is employed by a specific program of repute, this may mean that he or she is qualified. However, the workshops are liable merely to reflect the approach of that program. This may, of course, be exactly what you want. But it may not be. If the latter is the case, how can other qualified consultants be identified?

There is presently no national or even local certification of consultants as qualified to run such programs. Those who have published in reputable publications, who have spoken at important thinking skills conferences, and/or who have a good reputation with other schools are likely to be good initial candidates. What we are recommending here is, of course, that you apply the same standards of good sense and critical thought in seeking a consul-

tant that you may be trying to promote in your students when you ask them to make sure they get their information from sources they have good reason to believe are reliable.

Peer Coaching as a Support System for Teachers

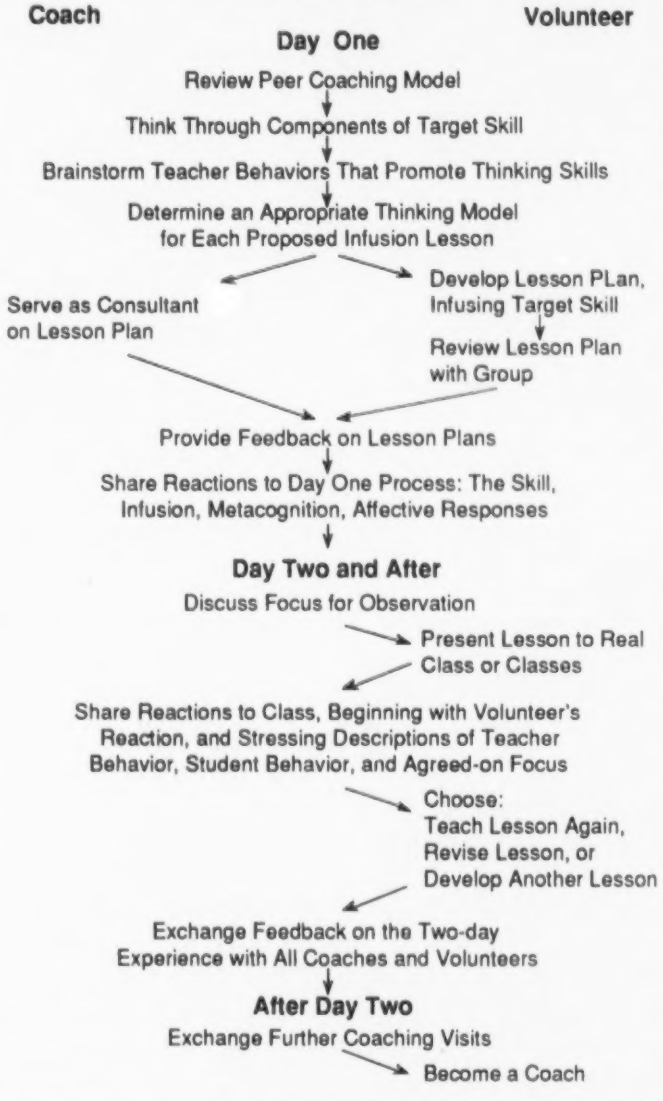
There are, however, two possible shortcomings to staff development programs that rely on outside consultants. While there are a number of qualified people available, their availability still falls short of the need. Second, since there are no standardized fees in this area, cost may be a factor. Sending teachers to off-site programs when consultants are not available for work in a particular school is an alternative that meets one of the difficulties, but it too has obvious problems in the commitment of travel time and time away from home.

Peer coaching arrangements, now widely used in many schools, avoid or minimize these shortcomings. Peer coaching is set up so teachers from the same school who have some expertise in teaching thinking work with other less experienced teachers in teams or groups. This helps them use existing material well or, more frequently, develop, hone, and implement their own thinking skills lessons. We will illustrate this technique in some detail because it is so widely used today. We choose a situation in which teachers are working together on an infusion project.

A middle school in Bedford, Massachusetts, uses the plan depicted on the next page to map out what happens in a two-day peer-coaching session designed to yield some accomplished thinking skills lessons.

In a typical two-day session the following might happen. Four coaches meet together in a group with four less experienced teachers who have volunteered. One experienced coach leads a discussion of what is involved in a specific form of thinking, e.g., the skill of making well-founded predictions. The group explores examples, and attempts to break out a "map" of this kind

Table 8.1. Peer Coaching Among Teachers: The Bedford Model


Coach
Volunteer
Day One
Review Peer Coaching Model
Think Through Components of Target Skill
Brainstorm Teacher Behaviors That Promote Thinking Skills
Determine an Appropriate Thinking Model for Each Proposed Infusion Lesson
Serve as Consultant on Lesson Plan
Develop Lesson PLan, Infusing Target Skill
Review Lesson Plan with Group
Provide Feedback on Lesson Plans
Share Reactions to Day One Process: The Skill, Infusion, Metacognition, Affective Responses
Day Two and After
Discuss Focus for Observation
Present Lesson to Real Class or Classes
Share Reactions to Class, Beginning with Volunteer's Reaction, and Stressing Descriptions of Teacher Behavior, Student Behavior, and Agreed-on Focus
Choose: Teach Lesson Again, Revise Lesson, or Develop Another Lesson
Exchange Feedback on the Two-day Experience with All Coaches and Volunteers
After Day Two
Exchange Further Coaching Visits
Become a Coach

of thinking, highlighting points to be stressed in instruction. This might then be written out on the blackboard. It might, for example, look something like this:

Prediction

1. What things might happen as the result of a particular event?
2. What sort of evidence could you get now that would make these possibilities likely or unlikely; e.g., from past experience or from reliable sources?
3. What evidence do you have that is relevant to what will happen?
4. Which possibility is rendered the most likely by the evidence?

Then, either working in a whole group or in pairs, the volunteer teachers develop lessons to teach this skill which use standard curricular content into which the thinking skill instruction is infused.

A sixth grade teacher, for example, might pick a story that students are reading. He/she might then use the "map" of predicting that they just broke out as a basis for her lesson design. The lesson might involve the following two stages which take place on two consecutive days. First, he/she posts the "map" on the wall of the classroom and comments to the students that they will be reading a story and will try to make some good predictions about the characters in the story. He/she then gives the students only part of the story to read. They then list things they think certain characters might do in various situations which he/she gives them that occur later in the story. Here the teacher would stress open brainstorming of possibilities. Then they think about—and make note of—what reasons (or evidence) they might find that would make one or another of these possibilities likely ways that the characters would behave. When they have done this, they turn

to the part of the story they have read and look for such evidence. This would help them settle on what they think is the most likely thing that the characters would do. They each explain this to the class along with the reasons they have for thinking that their predictions are likely.

Since this is likely to take up a full class period, the teacher plans to ask them to write a continuation of the story as homework, playing this out in a way that keeps the actions of the story character "in character." Finally, on the next day, they are to read the rest of the story. If the character does something different in the situation than they predicted, they can go back and try to find evidence in the story that they might have missed that would indicate that the character would react the way he did in the story, and not as they predicted.

To follow this up with some metacognitive activities, the teacher plans to ask them to discuss what the most difficult part of making a good prediction was for them, and how they could do it better next time. He/she plans for there to be a "next time" a week or so later when they will be asked to perform a similar activity.

After the lessons are developed, the peer coaching group usually meets again, and each member presents his or her ideas for reaction, comment, and suggestion. The lessons are then revised.

This lesson planning takes day one of a two-day peer coaching session. During the second day, each teacher does the lesson with his or her students, observed by the peer coach. They then meet and discuss how the lesson went. The peer coach is careful to give supportive and constructive feedback to the volunteer. After these discussions, the whole group meets again for a debriefing. They discuss what went well, and what problems there were. They then make a final revision of the lesson. This is repeated a number of times during the school year for other thinking skills.

There are many variants on the idea of peer-coaching. This example, though, indicates how reliance on teachers as peer coaches who are on the staff of a school, and the collegial atmo-

sphere in which such work takes place have made this a favored way of developing more of a focus on thinking in many schools.

There are some cautions that many schools using peer coaching have observed in relying on it in their staff development programs. Effective peer coaching depends on the availability of qualified coaches. Even though peer coaching relies on a collegial relationship and not on one of "expert" and "novice" to reshape a school curriculum, it is important that the coaches be sensitive to the distinctions and nuances in teaching thinking. In this way they can help their less experienced colleagues if they are confused or miss opportunities for using important teaching techniques. This means that the coaches themselves should at least be well-read in the field and should have already developed and used lessons for teaching thinking with their students. Where possible, the coaches themselves should have participated in some workshops on teaching thinking.

A second potential problem is only partially met by relying on qualified teachers as peer coaches. Since peer coaching works better in small groups, the locus of lesson development is greatly decentralized in the school system, and even more so from system to system. The danger is that overly diversified conceptions and approaches to teaching specific skills will result. To meet this potential problem, many schools and school systems have developed their own system-wide framework for teaching thinking that grows out of more extensive studies than such peer coaching groups can sustain themselves. These school systems, for example, may "prep" such peer coaching groups with written material on thinking and teaching thinking. In some cases, schools that use this support structure do so only *after* intensive study of the field—perhaps even for a full year—by teams from the school system. This may result in the teams developing their *own* framework and set of goals for teaching thinking in the system, reflecting their version of some of the major approaches in the field today. For this to remain viable, such school systems should also keep up with the latest advances in the field through the pub-

lications that are a forum for written reports of these advances, such as *Educational Leadership*, published by the ASCD.

There are obvious virtues in utilizing this type of reinforced peer-coaching in staff development programs directed at bringing a major emphasis on teaching thinking into a school or school system. The more these efforts are based on mainstream work in the field, the more connected they will be with what other teachers do in other schools to teach thinking, and the less insular will be the approach. Ideally, such efforts should yield a rich diversity of approaches and techniques, set in the context of a common conceptual and pedagogical framework for teaching thinking. We hope this book series will help to provide such a framework.

Concluding Remarks on Support Systems

What emerges from this discussion is an endorsement of the discriminating use of a plurality of support structures for in-service teachers. These include selecting qualified consultants, using high-quality written support material, and utilizing ongoing peer-coaching efforts. The latter are based on a well-thought-out plan of action to bring a major force on thinking skills into a school. We must stress, however, that the success of this movement depends not just upon the work of researchers/writers in the field like ourselves, or the work of teachers who are thinking about what they can do in their own classrooms. Crucial to this process are school and college administrators. Only they can provide the institutional leadership and support needed to make this effort a success in their own schools and school systems.

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CHAPTER NINE

APPROACHES TO EVALUATION

Educators engaged in the conventional teaching of the conventional subject matters enjoy a great luxury: they do not have to worry much about evaluation. To be sure, "accountability" is becoming a new favored word that encourages attention to scores in mathematics, reading, and other subjects. But consider the advantages enjoyed by those dealing with the traditional curriculum. No one doubts that reading, mathematics, history, and so on, are legitimate subjects worthy of study nor that students can accumulate some degree of knowledge and skill in these domains. No one questions that reasonably thoughtful and careful instruction will yield learning. Moreover, a vigorous testing industry with a long history supplies a diversity of options whenever we want to measure students' aptitudes and the impact of instruction.

This trust in the conventional educational enterprise and the numerous commercially available ways of testing (when testing is called for) are luxuries of the established, and the educator venturing into the domain of thinking skills must do without them. Many question whether thinking skills can be taught to any significant extent. To be sure, we have mentioned in earlier chapters evidence that instruction can help students to develop better thinking. Nonetheless, plenty of skeptics remain among parents, school board members, educational leaders, and students themselves. Moreover, granting that in principle education can improve students' thinking, we still have to ask what approaches to the teaching of thinking serve well, and which serve best. Educators need to know, not only in order to justify their plans to school boards and other concerned parties, but, most of all, to ensure that they are effectively finding fruitful directions that lead to the development of students' thinking. While the circumstances call for definitive tests of thinking, inevitably the testing industry

lags behind in this new domain, offering a scattered selection of sometimes questionable instruments.

To some degree, "unbelievers'" demands for sound evaluation of efforts to teach thinking are unfair. Because of traditional sanctions, many conventional parts of the curriculum need not pass under any such microscope, even though their contribution to the ultimate wisdom and well-being of students may be doubtful. For instance, does history, as it is typically taught, either impart a genuine understanding of historical patterns and forces or inform students in ways that lead them to think better about current events? How many students find in their studies of algebra or plane geometry either genuine mathematical insight or significant applications later in life? If unimaginative instruction in these domains survives because of the notorious momentum of educational practice, why burden the budding impetus of the thinking skills field with strict evaluation?

This reactive stance against evaluation, however, has little merit. First, as we have already remarked, efforts to develop students' thinking are largely underevaluated, not overevaluated. While many constituencies may clamor for sound evaluation of the teaching of thinking, little evaluation in fact accompanies most projects. Second, just because tradition has allowed some conventional teaching to go unevaluated for a while, this is no reason to urge that efforts to develop students' thinking also not be evaluated. On the contrary, the conventional instruction needs closer evaluative scrutiny, too. Indeed, perhaps most of all it needs scrutiny in keeping with the teaching of thinking: Does history, math, or other instruction help students to think better about these subjects? Does it genuinely develop students' understanding? Does it sharpen their problem-solving skills in the domain in question? Such questions as these show that attention to evaluation not only can serve well the teaching of thinking but perhaps also can restore accountability to some aspects of conventional instruction whose practitioners should be more attentive to this matter.

True, evaluation can be overemphasized. Unsound evaluation may do more harm than good. School systems implementing efforts to teach thinking must ponder the practicalities of what kind and scope of evaluation they can afford and whether they have the technical resources, machine and human, to implement it. It is our hope that the basics laid out in this chapter will give educators assistance with the decisions that have to be made if evaluation is to enhance efforts to develop students' thinking.

Dimensions of Evaluation

We have explained why there is a genuine need for evaluation in the thinking skills area. With that established, we need to examine and respond to the question most frequently asked by educators involved in the teaching of thinking, "What test should I use?" The query is a natural one. The catch is that the question is hard to answer. First, there are not as many testing options as one would like. Second, the manner of testing depends crucially on a number of other decisions related to the purpose of the evaluation, how novel or tried an approach is, and related matters. In fact, we will devote the greater part of this chapter to considering particular approaches to testing. That gives all the more reason to defer the "what test" question in favor of a look at some basic decisions anyone has to make in order to proceed wisely with an evaluation.

Purpose. Why would we want to evaluate students' thinking? —For many of the reasons that apply throughout education. Grading students through homework and tests honors and motivates achievement in the individual. Motivation is a goal of evaluation at higher levels of the educational hierarchy, too. Here, for example, teachers are assessed by the success of their students, or school systems are assessed to determine whether they are progressing on state-mandated objectives in thinking, history, or English. But motivation is far from the only aim of evaluation. More detailed evaluations—for instance, the comments of a teacher on an essay meant to display critical thinking—are intended not just to assess but to inform, helping the student to recognize strengths to preserve and weaknesses to repair.

Table 9.1. Purposes of Evaluating Students' Thinking

1. Honoring and motivating achievement
2. Teacher assessment
3. School assessment
4. Help students recognize strengths to preserve and weaknesses to repair
5. Serve as basis for assigning different thinking activities or topics
6. Justification of the effectiveness of a particular methodology

At the course or program level, detailed evaluations may point toward important improvements. Evaluation of student aptitudes or progress can provide the basis for assigning different types of thinking activities or topics. Evaluation also can justify the effectiveness of a particular methodology or offer a basis for selecting method A over method B. These diverse options make asking for the purpose of an evaluation an imperative early question. Does one want to motivate, inform, revise, select, justify, or some combination of these? The answers carry implications for the type of evaluation to employ.

Data gathered on what? Evaluation of thinking inevitably involves the formal or informal gathering of information in some sense about students' thinking. But what is gathered can vary considerably. Most evaluations collect data about students' performances, but there are other options. Other kinds of information—about the quality of dialogue in a classroom, teacher behavior, student absenteeism, and student attitude—may call for attention. For instance, in developing an approach to teaching thinking it is often important to ask whether a particular lesson is successful. "Success" here is not so much a matter of whether the

students learn what they are supposed to, but whether, in terms of presentation and student responsiveness, the lesson flows well.

What is being evaluated? The source of the data is not necessarily the object of the evaluation. For example, in evaluating a new program to develop students' thinking, one certainly will want to gather performance data from the students. But the course, not the students, is being evaluated. It is important to keep clearly in mind the entity being evaluated—student, course, teacher, school system, etc. What the source of the data is should be considered separately from the object of evaluation.

How close to the instruction? Another important dimension of educational evaluation concerns the closeness of a particular evaluation to the actual instruction. Multiple possibilities for timing and context arise in evaluating students' thinking. End-of-the-term evaluation affords an overall assessment of student progress. Complementary to it, however, is more frequent and informal evaluation, since end-of-the-term evaluation inevitably lumps together factors that evaluation based on day-by-day observation can separate. Delayed evaluation—for instance a test administered a month or six months later—can assess whether instruction has yielded lasting improvement in thinking. Evaluation in other contexts—for instance, a physics-relevant mathematics quiz in physics class—can gauge whether students are transferring thinking skills from one subject matter to another.

Unfortunately, positive evaluations relatively close to the instruction are no guarantee of more widespread effects: knowledge and skill often do not transfer and often fail to survive summer breaks. But neither can one safely use only measures more distant from the instruction. If they prove negative, one does not know whether this reflects problems of preservation or transfer or whether the material was not learned well in the first place.

In general, evaluation of any skill learning, including thinking skills, should not involve tasks identical to those used in the instruction. By definition, acquisition of a skill requires the ability

to handle *new* examples. Thus, a proper test of skill can never be so similar to the instruction as to call for a rote performance.

What attributes are tested? Finally, there are all sorts of attributes one might seek to measure. In evaluating the impact of a thinking skills course, for example, one might look for an impact on many different attributes of students:

- IQ;
- grades in other courses;
- performance on such open-ended tasks as essay writing;
- retention of and skill with any thinking strategies directly taught; and
- systematicity in planning and problem solving, etc.

In general, the six categories of improvements when thinking gets better that we discussed in chapter 2 provide useful categories within which we may want o measure the impact of the teaching of thinking. They are

- awareness of one's own thinking;
- investment of effort in one's thinking;
- attitude towards thinking processes;
- organization of thinking processes;
- development of subskills; and
- smoothness in the thinking process.

We will return to this question in the context of discussing various instruments of evaluation.

Evaluation of Approaches to Teaching Thinking

One might evaluate many different objects as part of developing students' thinking; for instance, students, teachers, school systems, or classroom ambience. Most educators, however, when getting started have a special interest in evaluating one or more *approaches*. Through this evaluation, it is possible to revise them and to decide whether to continue an approach or to de-

termine which approach to continue. In other words, the entity being evaluated is the approach; the purposes of the evaluation are revision and decision.

It is useful to distinguish between three kinds of evaluations of approaches. *Design evaluation* occurs before one tries out an approach; one simply is assessing its merits from afar, typically in comparison with other options. Both a decision as to whether to try an approach and revisions prior to implementation are purposes of design evaluation. *Formative evaluation* occurs during the first trial or two of an approach, in an effort to get it running smoothly. Revision is the principal objective of formative evaluation, with decision a possible but secondary consideration. *Summative evaluation* occurs after a program is running smoothly, in order to assess whether it provides the desired results. A decision as to whether to continue the approach or drop it is a major purpose of summative evaluation, with revision another consideration. We discuss the three kinds of evaluation in turn.

Design evaluation of approaches

Design evaluation was in fact the major focus of chapters 6 through 8. There we took up in turn a number of considerations important in assessing an approach prior to trying it out in practice. The present remarks accordingly amount to a condensed reminder and review.

Design evaluation is principally a matter of thoughtful examination of locally developed or packaged approaches, utilizing whatever general principles and information are at hand. The "data" gathered from conversation and published sources concern the approach itself. We want to determine whether a particular approach has elements that we can reasonably expect will achieve our goals in teaching thinking. The attributes gauged include whether it seems teachable, whether any strategies it seeks to teach seem sound, how it has been rated on prior summative evaluations, and so on. The evaluation may be relatively close to the instruction in the sense of proceeding lesson by lesson, or it

Table 9.2. Three Kinds of Evaluations of Approaches

Design Evaluation

- Occurs before the approach is implemented
- Helps determine whether to use the approach
- Guides for early revisions

Formative Evaluation

- Occurs during first trial or two of an approach
- Goal: to get the approach running smoothly
- Principal objective: revision

(Formal) Summative Evaluation

- Occurs after a program is running smoothly
- Requires formal testing instruments
- Assesses whether it provides the desired results
- Assesses whether revision is desirable

may be more holistic, looking to the general outline and spirit of the enterprise.

While we certainly cannot give a definitive list of standards, it is possible to outline several attributes that both research and theory recommend as important. A look at the following points is a worthwhile step in any design evaluation.

The skills addressed. Do the skills addressed seem worthwhile? To recall a useful criterion suggested in chapter 7, can one see readily how the skills would result in important general kinds of thinking such as problem solving and decision making? Do the strategies taught seem likely to be effective? Do the skills directly concern the desired performance, or, for example, are skills of formal logic taught in hopes of enhancing everyday decision making? (Such indirect connections are risky.) Are the skills well-organized, so that students can easily see them in relation to one another? Are they few enough to prove manageable? (Students are unlikely to be able to master dozens of skills at

a time.) Are the skills too broad to be meaningful or teachable, as discussed in chapter 3, for very general skill categories like "analysis" and "synthesis"?

Attention to attitudes and styles. As we emphasized earlier, good thinking is not a matter of skill alone. Does the approach implicitly or explicitly encourage fertile attitudes and cognitive styles? Does it "practice what it preaches" in being a good model of desirable attitudes and cognitive styles?

Perception of need and opportunity. Does the approach help students perceive just why particular skills are useful, strategies are empowering, attitudes are important? Instruction that just says, "Do these things and you will think better," is less likely to succeed than instruction that takes pains to heighten students' awareness of the properties of mind that motivate what is taught. For example, attention to defining and redefining problems as a strategy becomes much more sensible once students know about the strong human tendency to be solution minded. This tendency can be discussed or, better yet, demonstrated through classroom activities.

The acquisition process for strategies, attitudes, and styles. Some feel that a generally enriched intellectual atmosphere improves students' thinking through processes of "osmosis" or exercise. Research suggests that this is deceptive. Some students may improve, but mostly because they are figuring out how to handle the task well. In general, instruction designed to improve thinking should deal explicitly with the strategies, attitudes, and styles desired as well as modeling them. This does not mean that everything has to be taught directly. Students, for instance, can be provoked to invent their own strategies. One can use Socratic methods to draw from the students insights about useful strategies, attitudes, and styles. But, one way or another, explicit attention is called for, as indicated in chapter 7.

Internalization. New patterns of thinking need time and practice to become comfortable and habitual. Otherwise, they tend to fall away. This is not just a matter of affect: freshly acquired

ideas take up more room in human short term memory and thereby actually get in the way of their own fluent utilization. Many approaches do not provide much practice—because the ideas seem so simple—or escalate the difficulty of practice too quickly, so that students find themselves "practicing" on problems that they cannot really do. While it is hard to say how much practice suffices, broadly speaking one should look for plenty of relatively easy practice to ensure internalization.

Transfer. As we emphasized earlier, transfer of strategies, attitudes, and styles cannot be taken for granted. Very often, what students learn in one context they never think to apply in another. This means that a well-designed approach should make explicit provision for transfer. This can be accomplished, for instance by drawing students' attention to the problem, providing exercises that deliberately bridge to other contexts, and asking the students to generate applications in other contexts.

Sustenance. This theme really applies not to the approach itself but to its setting. There is little point in striving to develop students' thinking through special instruction—integrated with a subject matter or not—unless the larger instructional context sustains the skills in question. For instance, after learning some strategies for creative thinking or assessment of evidence, do the students encounter further opportunities in the classroom to deploy those strategies? Or does classroom procedure revert to mostly factual questions and one-right-answer problems?

The several points listed above all bear consideration during a design evaluation. This is true not only because they represent common sense and research findings but also because, in fact, many locally developed and packaged approaches are deficient in one or more of them. Of course, if an approach exhibits gaps, this does not mean one must reject it. One can instead repair it. This is just as true of packaged programs as home-grown approaches. For instance, if a packaged program lacks good bridging for transfer, one might decide oneself to design that element and include it.

Formative evaluation

Suppose an approach has passed the test of design evaluation and one is implementing it. Then formative evaluation, with its principal purpose of revision, becomes relevant. Any fresh approach will have rough edges—often *very* rough edges. Formative evaluation, therefore, should be concerned not so much with the ultimate utility of the approach as with getting the approach functioning well in its own terms. In general, an approach should be tried out at least once with formative evaluation aimed at revision before it is subjected to a summative evaluation with its more severe "accept/reject" implications.

One might ask whether this holds equally of locally developed approaches and polished packaged programs. Formative evaluation often is important for the latter as well. To be sure, a packaged program has already gone through a process of formative evaluation and refinement during its development. Nonetheless, program implementation often presents significant obstacles due to the particular circumstances. One may have to adapt a packaged program significantly, and one always needs time to adapt to it. Consequently, we suggest at least one round of teaching a packaged program as a shakedown period of formative evaluation.

Formative evaluation implies certain things about the kind of data to gather, the kinds of attributes to examine, and the distance to maintain between the evaluation process and the actual instruction. The formal apparatus of pretesting and posttesting with control groups and similar procedures most typically is too distant from the instruction. The first teaching of an approach often proceeds so roughly that one cannot expect good results from such tests. Moreover, they typically do not yield extensive information about how to revise the approach. Instead, the evaluator needs to follow the teaching process closely, examining the instruction as it proceeds lesson by lesson. Rather than emphasizing data gathered just on students, one often gathers at least as much data on the general flow of a lesson.

Relevant attributes include students' apparent understanding of ideas, how well a lesson teaches, whether the teacher feels comfortable with it, whether the lesson content seems clear, and so on. The points raised in the *design evaluation* section all bear reconsideration during formative evaluation. Usually the data gathering is semiformal, through notes made by the teacher, examinations of homework and seat work, peer observation and feedback, and so on. An extremely tight methodology is unnecessary, because freshly implemented approaches display blatant problems that do not need such a methodology for detection.

The revisionary emphasis of formative evaluation does not imply that it cannot provide the basis for an "accept/reject" decision. If an approach works out so poorly during a shakedown period that it appears to show little promise, certainly one can then abandon it. Perhaps a better approach is being considered in parallel. However, most often one will not want to make a final decision during formative evaluation, especially during the first round. Rather, teaching the approach should continue for a longer period of time.

Summative evaluation

Before discussing summative evaluation, let us ask whether a teacher or school system should take seriously its challenges. For formative evaluation, there is little choice. One can engage in the task of formative evaluation more or less seriously, but it is always appropriate, even, as emphasized earlier, for well-developed packaged programs. For summative evaluation, however, one might wonder. Can a proper summative evaluation be handled with the typical resources of an individual teacher or even a school system? If the approach in question is a packaged program with evaluation data, why not trust that?

In general, for several reasons we do recommend summative evaluation. Summative evaluation presumes that an approach is running smoothly; it assesses objectively whether the approach is meeting expectations. First of all, as we emphasized earlier, most packaged programs have not been well evaluated. Moreover,

educational settings differ considerably and what works well in one setting may not in another. More evaluative information from many contexts is an important contribution to the evolving field.

Second, as we stressed in earlier chapters, one cannot assume that a thoughtful, well-organized effort to teach thinking will have a significant impact on students. While almost any such effort to teach some history, grammar, or mathematics will improve student performance, this simply is not so for the teaching of thinking. Students can be counted on to learn some content, but the teaching of thinking has modest content in the conventional sense. Instead, it highlights process skills at a significant level of abstraction. These are not so readily or reliably learned. Furthermore, it is easy to deceive oneself through informal observation about the impact of an approach. Several students may "catch on" and even report interesting applications in other contexts of the thinking skills they have been learning. But this does not mean that the majority of the students are empowered at all by the instruction. We do not mean to be discouraging—just careful. Only a thoughtful summative evaluation will gauge an approach's true impact.

Despite these arguments, it has to be acknowledged that conducting a full-scale summative evaluation of a program involves a number of technicalities that may not prove practical in some educational settings. We think it useful, therefore, to distinguish roughly between "informal" and "formal" summative evaluations. A formal summative evaluation pays heed to all the traditional elements—control groups, statistics, and so on. Normally speaking, a number of individuals in different roles are involved in a formal summative evaluation. In contrast, an informal summative evaluation can be done alone by an individual teacher curious about student progress. In an informal summative evaluation, most of the traditional evaluation elements are left aside. After discussing summative evaluation in general, we will return to the question of formal versus informal summative evaluations.

Granting the importance of summative evaluation of an approach, what kind of evaluation is it? Here the dimensions introduced earlier can help again. The principal purpose of such a summative evaluation, as we mentioned before, is to decide how well an approach is meeting its objectives and so whether or not to continue it. Data are gathered primarily on individual student performance, not, for instance, on how well a lesson goes or the classroom ambience. These are more appropriate to formative evaluation. However, the object being evaluated remains the approach, not the students.

Summative evaluation is not as close as the other types of evaluation to the teaching process. Normally one tests after, and often before, the instructional program, but not in the middle. Sometimes, one tests individual units summatively when they each run a number of weeks. In the area of measuring attributes, while formative evaluation attends to students' immediate reactions—affective and cognitive—summative evaluation typically addresses students' attitudes and performance. This is accomplished through instruments that measure what the overall intervention intends to achieve in broad terms. Having made these general points, we would like to comment further on those from whom data is gathered, how close the evaluation is to the actual instruction process, and what attributes are tested.

Who provides data: when does one need a control group? Often in summative evaluation, one needs a control group. This is a group of students who are similar in age and general ability. They receive no special treatment, but they are given the same array of tests on the same schedule as the group undergoing instruction. One assesses the impact of the approach not just by examining whether the treatment group improved relative to the pretest scores but by whether the treatment group improved significantly *more* than the control group.

Why is this sometimes needed? Because students become better at many thinking skills in the course of time and normal instruction. For example, imagine a new two-semester approach to

developing higher-order reading skills. In the course of two semesters, students' reading will improve anyway. So, in evaluating the new approach, it is imperative to compare gains in response to the approach with control group gains.

This does not mean that a control group is needed in all instructional situations. When instruction is relatively brief, one does not usually need a control group. Thinking skills simply do not improve much over a brief period under normal instruction. Also, if the instruction falls well outside the sorts of skills normally developed by schooling, one may not need a control group. For instance, skills of creative thinking are hardly addressed at all in conventional education, so one might view a pretest-posttest comparison as sufficient in evaluating a semester course. Finally, if prior research already has shown that the skills in question develop very slowly, one can do without a control group. For instance, research has demonstrated that normally students' informal reasoning abilities hardly advance at all in the course of a year; consequently, a course of instruction in informal reasoning might well be evaluated without a control group.

How close to the instruction: "bracketing" with pretests and posttests. In summative evaluation, one does not normally test students frequently. While formative evaluations may include gathering information in a classroom nearly day by day, summative evaluation normally involves obtaining data only at a few points. Nearly always there is a posttest shortly after the completion of instruction. As we noted earlier, sometimes individual course units comprised of several lessons are tested summatively. Often, a pretest is given.

What is the purpose of a pretest? A pretest provides a baseline against which to compare students' gains in response to the approach. For instance, suppose that one is teaching a set of skills useful for decision making. Students will certainly already have *some* ability to make sound decisions, and one would not want to credit to the instruction this already existing ability. By pretesting and comparing the results with posttesting, one can isolate the

impact of the approach. An added advantage is that pretesting and posttesting permit working with "gain scores"—each student's posttest score minus pretest score. Gain scores automatically adjust for the fact that some students will perform better at the beginning than others by measuring each student against himself or herself; this allows a more sensitive comparison with a control group that also receives pre- and posttests.

With pretesting and posttesting comes a technical issue about repeating tests. One wants to measure the same thing before and after, but can one use the very same instrument? The risk is that any gain students display on the posttest will simply reflect their familiarity with the identical pretest. When there is a control group, this problem solves itself. The control group, too, has received the same test twice and benefited from any retest effect. Therefore any special treatment received by the students in question and not received by the control group will not be due to a repeated test.

When there is no control group, one may want to have variant versions A and B of the test. Half the students receive A and half B at the outset; at the end, those students that took A take B and vice versa. This guards against retest effects due to repetition of the identical questions. It does not, of course, guard against retest effects due to catching on to the style of the test. Also, it sacrifices the precision gained by retesting with exactly the same test and so measuring each student twice in just the same way. The A-B method is most appropriate when the instruction is brief and the pretest likely to be remembered. For instructional sequences of the order of a semester or more, it may be preferable to administer the identical test, assuming that the students remember little of it. Safest of all, of course, is the control group comparison.

Just as with control groups, pretesting also is not always necessary. It is called for only when one can expect that the students already bring to the instruction some ability with the performance in question. In the case of teaching thinking skills, this is usually

the case, so pretesting is usually desirable. But there may be special contexts of teaching thinking where pretesting is not needed. Imagine, for instance, the first course a student takes in plane geometry taught with an emphasis on problem solving. There would be no point in a pretest on problem solving in geometry: the students do not know any geometry yet!

How close to the instruction: testing for transfer and retention. Any summative evaluation should test upon completion how well the instruction achieves its most immediate objectives. An example would be the geometry problem-solving test administered immediately after the course. Proper evaluation of skill learning has to involve tasks not identical to those used in the instruction, because learning a skill *means* learning something applicable to new situations. For instance, one would not test arithmetic *skills* on the same examples worked for practice, whereas one might test knowledge of number *facts* on the identical number facts (indeed, one could not do otherwise since there are no new number facts). Likewise, thinking skills should be tested with new tasks. Of course factual knowledge about thinking skills (also of some importance) might well be tested through questions the students have heard before. One might call the evaluation of students' ability to apply skills to new tasks "testing for very near transfer," or, by the same token, one might not want to consider it a matter of transfer at all. But whatever the label, the need for new tasks is important in evaluating a skill.

Transfer in the normal sense. Besides this point, two other issues of evaluation also invite attention: (1) transfer in the normal sense of transfer to tasks and contexts different in kind, and (2) retention. Transfer is the issue when one wants to know whether the students carry over to other types of problems and other contexts what has been learned. For instance, in the case of the geometry problem-solving course, one might hope that the students' *general* problem-solving abilities would improve. To measure this one would need a geometry problem-solving posttest to gauge the effectiveness of the instruction on its most immediate objectives,

and also a general problem-solving pretest and posttest to gauge more substantial transfer effects.

Besides giving posttests designed to detect transfer, one can take advantage of student evaluations in other settings. For instance, do students' course grades go up in other subject matters? Does their performance improve on standardized tests administered as part of the school routine ?

While these are manageable questions, some sorts of transfer are very hard to measure. One might like to know, for example, if the geometry course alluded to improves students' everyday decision making. But short of following the students around with an invisible cloak and a tape-recorder, this is very hard to determine. While anecdotes from individual students may demonstrate that such transfer happens with some students sometimes, this is a long way from knowing that it happens often or with most students, which is what one would really like to ascertain. Like all persons committed to education and its widespread impact, we are encouraged by such anecdotes. But we caution against taking them as strong evidence of widespread transfer.

Besides taking account of these points on measuring transfer, one should remember a principle emphasized at several junctures in this document: transfer is hard to achieve. To obtain it, one usually must teach for it. Also, one should have reasonable expectations and not waste time testing for transfer unless there are some grounds for expecting to find it. For instance, the geometry problem-solving course alone would be quite unlikely to improve students' general problem-solving skills. It would be necessary to take special care in the instruction to teach for transfer, drawing in nongeometry problems from time to time, having the students generate applications outside the course as homework assignments, and so on.

Retention. Testing for retention is especially straight-forward conceptually, although it may be inconvenient to schedule. One simply needs to retest students on the same matters assessed at the end of the instruction but with a delay. One might, for example,

retest after a month, six months, or a year. Such retesting raises the same technical issue of repeating a test that occurs for pretesting and posttesting and allows the same solutions.

With retention as with transfer, there is an issue of reasonable expectations. One should not anticipate perfect retention with thinking skills any more than one would with history knowledge. The impact of instruction may fade in anything from a few months to a couple of years. Should one be discouraged? No—for several reasons. First of all, *sometimes* there is a lasting impact. Second, as with any subject, lasting gains come from repeated attention. It is naive to expect that a thinking skills intervention in, let us say, the fourth grade will advance students' minds for the rest of their lives, especially if, after the intervention, it is back to "instruction as usual." This is the issue of *sustenance* which we raised earlier. Why do children not forget how to read after they first learn? Because they are kept reading. Likewise, students need to be kept thinking after an intervention in order for the skills to survive.

What attributes to test: the pitfalls and plusses of testing what is taught. Imagine that, as part of some instruction in critical thinking, you are teaching students to examine advertisements for misleading arguments. Concerned to gather some evaluative information, you collect their written ideas about one advertisement before the instruction. Afterwards, you assign another advertisement for them to critique. According to plan, you find that they have become considerably sharper in detecting the ways that advertisements mislead. You're happy with that, to be sure, but you also wonder, "What have they *really* learned? After all, they just did what I taught them to do. Was I "teaching to the test"?

The worry is understandable: Sometimes merely testing what is taught is a fundamental flaw in an instructional intervention. But it depends. Sometimes testing what is taught is a very good idea. To understand the issue better, we need to recognize that tests can test more or less directly what one ultimately wants.

Suppose, for instance, that we are interested in the ability to solve everyday problems. We might do one of the following:

- We might seek to measure this by posing a series of everyday problems and scoring responses by such criteria as imaginativeness, workability, and efficiency.
- Second, we might prepare a series of problems with multiple choice solutions, asking the test-takers to choose which solution seems best.
- Third, we might give an IQ test, in the belief that IQ reflects everyday problem-solving ability.

The first test measures everyday problem solving rather directly. The second test measures everyday problem solving somewhat indirectly. Choosing the best solution presumably has something to do with overall everyday problem-solving ability, but certainly it is not the same thing as having to make up one's own solutions. The IQ test is all the more remote: everyday problem-solving ability might have very little to do with scores on IQ tests. If a test measures directly what one wants, it is quite appropriate to teach to the test and test what one has taught. To continue the example, if one wants better everyday problem solving, one ought to teach for it—and test for it—as directly as possible. On the other hand, it is risky to teach to an indirect test. For instance, teaching to an IQ test in order to improve everyday problem solving is a poor choice. Typical IQ-test problems involve certain patterns of thinking that seem quite specific to that testing genre but not so relevant to everyday problems.

Another important point is that teaching to an indirect test tends to spoil the test as a measure of what you really want to evaluate. Before instruction, for example, a test of formal syllogistic reasoning might correlate moderately with everyday reasoning performance. After teaching to the test, students might be better at syllogistic reasoning, but the correlation between syllogistic and everyday reasoning scores might actually be lower. Why? Because before instruction the performance on the

syllogisms reflects whatever everyday reasoning powers the students can bring to bear on this odd task, but after instruction the performance on the syllogisms reflects how much each student learned about syllogisms specifically.

The moral of this tale is that one must be cautious in using an indirect test that has been shown to correlate with what one really wants. Such a test may make an adequate pretest. If not taught to, it may make an adequate posttest. But if taught to, it does not make a good posttest, because teaching to it may spoil its relationship to what one really wants to measure.

Coming full circle, let us consider again the case of teaching a critical posture toward advertisements. For a posttest, when you ask your students to write critiques of an advertisement, is this appropriately or inappropriately testing what was taught? In a way, the answer depends on your aspirations. If your aim was simply to raise students' awareness of deception in advertising in those situations when they focus on the matter—as in your assignment—then testing what was taught seems wholly appropriate. You probably also hoped that in less formal circumstances, such as watching TV at home, your students would become more alert to misleading advertisements. If that was part of what you really wanted, perhaps you should add some more informal kind of assessment. You might, for instance, unexpectedly ask students to write down several deceptive practices they noticed on TV during the last few days. If you hoped that attention to misleading advertising would improve your students' *general* critical thinking skills, then just testing them on a given advertisement is not nearly enough. You should ask them to critique messages quite different from advertising—perhaps newspaper editorials, for instance—to gauge whether they have acquired any general critical tools.

Formal versus informal summative evaluation. The foregoing discussion makes plain the complexity of a full-fledged, formal summative evaluation of any approach to the development of thinking. The individual teacher, wanting to gauge whether

students indeed are learning from a packaged program or a personal approach, may well and rightly feel daunted. As we noted earlier, an appropriate option for the individual teacher is what might be called an "informal" summative evaluation.

For example, suppose you are teaching ninth grade English. You plan to highlight skills of critical interpretation during a unit on essays: What is the author saying? Is it soundly argued? Does the author take up counterarguments? What is the import of the author's message? You wonder whether the students will assimilate the spirit and strategies of critical reading in this sense. You decide to assign a "pretest" essay for your students to read and comment upon before you introduce the unit. Then, after the unit is completed and after two or three weeks on another topic, you plan to assign a "posttest" essay for them to read and critique, without particularly reminding them of the approaches they learned during the earlier unit. You could then compare pretest and posttest essays side by side to see whether you can find definite signs of improvement.

As this example illustrates, an informal summative evaluation pares down to the minimum the apparatus of summative evaluation. Even more informal sources of information than this can be used in ordinary classroom situations. These include the results of student interviews, journal entries in which teachers note things that they observe about the kind of thinking students do, and checklists of expected student performance. Such data is especially appropriate when we are concerned about students' thinking attitudes. In such situations one uses a control group only if it is very convenient or if there is a blatant need. In the example above, the teacher judged that students were not likely to gain spontaneously on the skills in question and forewent a control group.

Notice that designing an informal summative evaluation requires thought about most of the features of a formal summative evaluation. One cannot, for instance, just ignore the question of control groups. One has to ask oneself whether there is a blatant

need. An informal summative evaluation is not a formula—always having this feature, never having that feature—but a minimally technical plan tailored to the particular situation.

With the shortcuts of an informal summative evaluation, of course, come risks. The fine points of formal summative evaluation all are designed to protect against error. Without control groups, pretests, statistics, and so on, it is much easier to deceive oneself into thinking that an intervention has impact. In fact, gains might be attributed, for example, to normal development, learning in some other course, or simple statistical accident. Because of these risks, positive results from an informal summative evaluation can virtually never be published in professional journals and should not be viewed as compelling by others on the basis of the numbers alone.

Nonetheless, an informal summative evaluation provides the teacher with much more information than *no* summative evaluation. Dramatic gains probably are meaningful; they may even encourage the teacher to recruit more help and proceed with a formal summative evaluation on the next thinking skills unit. Similarly, no appreciable gain at all is a reasonably good sign that the approach has a problem since, in general, the looseness of informal summative evaluation tends to favor seeming gains. Moreover, if an informal summative evaluation proves to be of special interest, one can strengthen it in some respects retrospectively. Although one cannot add a pretest after the instruction is done, one can learn and apply appropriate statistics, or recruit help with statistics. One also can involve other evaluators if there are questions of evaluation bias. For all these reasons, then, we recommend informal summative evaluation as a practical and informative alternative for the teacher not working as part of a larger team in the development of thinking skills.

Summary

In this chapter we have offered a broad overview of the multifold factors that figure in evaluating the teaching of thinking, with an emphasis on program evaluation. We have urged that

proper attention to evaluation involves a triple effort: design evaluation, formative evaluation, and summative evaluation, each in its own season. An evaluation plan involves multiple considerations—what to look for, when, how often, in what way, and so on. These are intended to gauge such matters as whether students learn what is taught, transfer it to other tasks and contexts, and retain it over a significant period. Important shifts of emphasis mark the transitions from design to formative to summative evaluation. For instance, the use of formal testing instruments is impossible in design evaluation, possible but usually a waste of time in formative evaluation, and essential in summative evaluation. Pitfalls and pseudopitfalls have been explored; for instance, the pitfall of neglecting control groups when you need them, and the pseudopitfall of teaching to the test or testing what you teach, which, properly understood, can be a legitimate and advantageous practice.

We hope that these considerations clarify the role and demands of evaluation in the teaching of thinking. We wish that evaluation were simpler than our remarks indicate. Indeed, a full-scale evaluation is a somewhat daunting enterprise. However, the individual teacher may adopt the recourse of an informal summative evaluation. Also, let us say in encouragement that a thorough evaluation looks less complicated once you are involved than it does before you start. For the price of its moderate complexity, one gains sharp information useful in revising and justifying efforts to develop students' thinking.

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CHAPTER TEN

TYPES OF TESTS

The previous chapter explored general considerations of design, formative, and summative evaluations. In this chapter we consider instruments that might be used to evaluate the development of students' thinking. We discuss objective tests, including tests of knowledge, problem solving, critical thinking, and intelligence, and we also discuss interpretive tests, where the scorer must exercise judgment.

While we go into some detail about instrumentation and the conduct of an evaluation, we do not pretend that the account given here suffices to allow uninitiates to carry off a formal summative evaluation. Rather, our intent is to say enough to give a realistic flavor of some of the complexities involved. Unless someone within a school system is already versed in such matters (which in fact often is the case), we recommend consultation with an outside expert about the design and mathematical technicalities of a formal summative evaluation. But teachers may well find sufficient information in these pages to plan an informal summative evaluation. As we urged in the previous chapter, this is a genuine and useful option. Finally, the third volume in this series, *Evaluating Critical Thinking* (Norris and Ennis, 1989), includes a much more extensive discussion of evaluation in the specific context of critical thinking. We therefore recommend that the reader especially concerned with matters of evaluation consult volume 3.

One general caution that applies to any test you do not design yourself needs immediate emphasis: the name of a test is not necessarily a good guide to the attributes tested. For instance, several different commercially available tests include critical thinking or reasoning in their titles. But one may be very different from another. While one such test may emphasize problems of deductive

reasoning, such as syllogisms, and may not address at all problems of assessing evidence or the reliability of observations, another will stress the latter. Likewise, there is no general consensus on what are "basic cognitive skills", and different tests that purport to measure such skills may turn out to measure quite different things. In short, the classic dictum of not being able to tell a book by its cover applies to tests as well. Responsible planning of evaluation must involve a look inside the candidate tests to see whether they measure what needs to be measured.

Section One: Objective Tests

Objective tests have long been the mainstay of educational testing. Whether they should provide the mainstay of testing for thinking can be questioned. There is a wide range of objective tests including, for example:

- most IQ tests;
- most commercially available academic aptitude tests;
- most commercially available academic achievement tests; and
- the tests in spelling, history, or mathematics that the teacher prepares and scores for the correct multiple-choice or student-provided answer.

With these examples in mind, what makes an objective test *objective*? There is more than one way to answer this question. For our purposes, an objective test is one that is scorable without significant interpretation on the part of the scorer. Note that an objective test defined in this way may sometimes involve rather subjective and interpretive problems from the test-taker's standpoint. But from the scorer's standpoint, there is an official answer and the scorer need only check for that official answer to derive the official score.

Such tests seek two laudable advantages: efficiency and scores independent of the scorer. They provide these through a multiple-choice or other right-answer format. The format allows no ambiguity regarding a correct response, at least as far as the official

scoring process is concerned. One not uncommonly finds that the official answer to a multiple-choice item is debatable, but, on the whole, objective testing avoids the ambiguity inherent in, e.g., grading an essay. The right-answer format also makes the scoring process efficient since the scorer need not ponder a test-taker's response. The scorer need only check whether it matches the official answer. Sometimes efficiency is enhanced by scoring templates as, for example, in the Watson-Glaser Critical Thinking Appraisal (Glaser and Watson, 1980). The thrust toward efficiency is epitomized in the machine-scored multiple-choice test.

One can conveniently characterize objective tests according to the categories laid down earlier for describing evaluations. Objective tests:

- typically achieve the purposes of summative evaluation;
- most often are premature in formative evaluation;
- gather data on the students rather than, for example, on teachers or classrooms;
- have as the object of evaluation the students and/or the approach;
- like summative evaluation, do not operate close to the instructional process. They operate apart from it, appraising its overall impact via pretesting and posttesting that may be scheduled immediately after the instruction or with a delay.

It is in the attributes tested that objective tests are most controversial. Using the terminology of the previous chapter, they are often *indirect* rather than direct measures of the educational objectives in question. Let us examine this issue under the following several headings.

Testing for knowledge

Objective tests offer a reasonably effective way of testing students for factual knowledge. This applies to knowledge about one's mind and how to use it well as much as to knowledge about

history or mathematics. The testing of knowledge also is relevant to efforts to teach learning skills. One straightforward measure of the effectiveness of such efforts is whether students after instruction display greater retention of what they study after such instructional efforts than prior to them.

There are some cautions to observe. The first concerns the contrast between multiple-choice tests and tests where the student must provide an answer. Multiple-choice tests tap recognition memory—the student's ability to recognize an answer as the correct answer or, at least, to recognize the other answers as mistaken. A multiple-choice test may substantially overestimate how much knowledge a student can produce on call. However, often one wants students to have knowledge that they can readily retrieve, not just recognize. Tests that ask students to provide the facts speak more directly to this objective.

A second and broader concern addresses the ultimate role played by the facts one learns. Presumably, we do not just equip students with facts so that they will know them when someone asks questions like, "When did Columbus discover America?" Rather, we want them to weave these facts into their thinking processes, using them, for example, when they read, write or converse. This use of facts is *very* different from either the multiple-choice or the provide-an-answer format. Commonly students who perform well on such tests display what psychologists call a problem of *inert knowledge*. It is there when the student is directly cued, but it is not retrieved when needed, for example, to make decisions.

This exact situation involving inert knowledge has proven to be a serious problem in medical education, with its tradition of filling students with facts about anatomy and physiology. Research has shown that, by and large, the medical students cannot use that knowledge actively in medical practice. This discovery has led to reforms in medical education centered on the theme of problem-based learning, where facts are learned in the context of practice. Students learning in this way do well on the knowledge

tests, but they also use their knowledge in problem solving and decision making.

What, then, is the moral about testing for knowledge? Objective tests are appropriate for assessing a person's knowledge base—but risky to teach to, because they are not very good measures of what we really want people to be able to do with that knowledge. Instruction should teach to the performance we really want: let us say, to medical diagnosis, not just to medical knowledge; or to writing insightfully about history, not just to historical knowledge. Then one can test for the factual knowledge aspect of this performance with objective tests.

This moral certainly applies to a student's factual knowledge of the mind and how best to use it. If one just taught for retrieval of the facts or *about* thinking (in the language of chapter 7), one would almost certainly find that students put little of that knowledge into practice. But if one teaches for the use of that knowledge (engages in the teaching *of* thinking), it would be quite appropriate to employ an objective test to assess how much of the knowledge the students have acquired. One would, of course, want to test for active use as well.

Testing objective problem solving

Education in mathematics and the sciences characteristically involves considerable problem-solving activity dedicated to objective one-answer problems. Typical examples include work on the elementary arithmetic operations in elementary school, algebra and physics problems in secondary school, and calculus and more advanced physics at the university level. Since better problem solving is a frequent aim of efforts to develop students' thinking, objective tests of problem solving certainly are a candidate measure for such efforts.

Tests of objective problem solving suffer less from the problem of indirectness than many objective tests. The logic is the following. One wants better objective problem solving: one tests students with batteries of objective problems. If they provide the correct answers, they have solved the objective problems. To be

sure, objective tests do not provide much information about *how* the students *go wrong* when they have difficulties. But it must be remembered that if one is undertaking a summative evaluation of an intervention's impact, one may not need such information. Or one may gather it in some other way.

One caution concerns the multiple-choice issue again. Many tests of objective problem solving employ the multiple-choice format. As any testwise student knows, it is often possible to narrow down or even determine the correct answer by eliminating competing answers rather than by working the problem. If one wants to be sure that students work the problems, it is best to avoid the multiple choice format. On the other hand, eliminating the competing answers often involves significant reasoning that may in itself reflect skill in the discipline in question.

A greater caution concerns not tests of objective problem solving in themselves but the image of mathematics and science that they project. Recall, for example, the conventional chemistry problem—complete with liters, grams, and moles— used for illustration in chapter 7. To be sure, it is important that students demonstrate mastery over problems like this. But mathematics and science involve much more than the solving of such problems. Testing that only poses such problems inevitably projects a distorted image of science and mathematics to students and teachers alike and at best tests for a narrow range of thinking skills used in such problem solving. Themes such as theory invention, experimental design, problem finding, and information gathering should be an important part of math and science curricula *and* testing, making the subject matters truer to their nature as well as much richer and more engaging.

Critical thinking tests

A number of tests have been constructed to measure a broader range of specific critical thinking skills than those incorporated into standard tests of problem solving. While most call themselves critical thinking tests, the skills assessed vary. Still, looking within these tests, it is easy to discern which skills are actually in-

cluded. In many cases, these are inferential skills—skills concerning deduction from givens or the strength of evidence for an hypothesis or generalization. In addition, some tests measure skills for uncovering assumptions, and a few include items that test for skill at determining the reliability of sources of information and the accuracy of observation. They almost all use a multiple-choice format.

Despite what we said about problem-solving tests, one might think that there is a serious problem in using a multiple-choice format to test these specific skills. Choosing an answer to a multiple-choice item does not reveal the thinking behind the choice. The response to this worry is nonetheless much the same as with tests of problem solving in mathematics and science. It is possible to construct test items so that choice of an answer in the normal case requires the use of the skill. For example, some items begin by giving the test taker a base of information, and then ask which of the responses listed is rendered *most* reasonable in light of the information. Presumably picking the right answer depends on having skill at determining when evidence makes a conclusion reasonable. Here is an example of such an item:

> Sergeant Kowak, after scrutinizing the village, reports:
>
> "The explorers can't escape, because they can't break down the walls of the stone hut." Which one of the following is probably taken for granted?
>
> A. The explorers can jump out the window.
>
> B. The guards are alert.
>
> C. All ways of escape, except through the walls, are impossible.

Practitioners can construct such test items themselves once they have a clear sense of what the skill is that they want to test. A thorough discussion of these types of tests is included in the third volume in this series, *Evaluating Critical Thinking*.

Such tests have limitations. In cases in which an answer may be chosen for a number of different reasons, some better than others, the test may not tell us what we want to know. For instance, if you were teaching social studies, you might make up a test item such as this:

> Some people argue that the president of the United States really has relatively modest influence on national direction. Whether this is so or not, which reason favoring the modest influence of the president carries the most weight?
>
> 1. It's the military-industrial complex that really calls the shots in the U.S.
> 2. The constitution strikes a balance between the powers of the president, congress, and the judiciary.
> 3. Presidents' wives are often the "power behind the throne."
> 4. The president is commander of the armed forces.

Such a question asks students to evaluate the relative weights of the several reasons. One hopes that students will think in something like the following way to choose an answer:

> "Let's see, number 4 talks about the president as commander of the armed forces; but that looks like an argument *for* the influence of the president, not *against*.
>
> "Now reason 3 with that 'often'—I don't think that's true historically. Reason 3 doesn't argue that the president has little influence, only that his wife is the real decision-maker, using whatever influence he has. Reason 2 still leaves plenty of room for influence from the president. So reason 1, about the military-industrial complex, looks like the strongest. I don't know that it's all that strong, but it looks like the strongest."

Even if a student checks answer 1, such reasoning is forever hidden from us and cannot be distinguished from simpler—and less interesting—forms of reasoning that might lead to 1.

A similar problem has been pointed out about certain critical thinking test items in which students with different background beliefs may choose different answers. For example, an item on one critical thinking test is part of a story about an expedition that has landed on the planet Nicoma. The test taker's task is to make a judgment about reliability (Ennis and Millman, 1985).

> Which is the most reliable report below? Or, if you think that they are equally reliable, select C.
>
> A. The health officer says, "This water is safe to drink."
>
> B. Several others are soldiers. One of them says, "This water supply is not safe."
>
> C. A and B are equally believable.

One student may select A, the keyed right answer, using as background information that health officers should know about the safety of water supplies. Another student, however, may reason as follows:

> Health officers are usually bureaucrats or political appointees who have little training in the wilds. On the other hand, soldiers are trained for survival in the wilds, so would probably be more reliable in their judgments about the safety of water supplies.

This student may pick B. It is not obvious that the second student is using faulty reasoning, yet his answer will be marked wrong.

A way to remedy this situation is to make sure that we don't include such items in a multiple-choice critical thinking test. But there is another way to remedy this situation. Let's look at it.

Objective tests of open-ended thinking

The desire to have one's cake and eat it too is a natural human impulse. On the one hand, we would like to have the benefits of objective testing—efficiency scores and scores independent of scorer. On the other, we would like to teach for and test for "open-ended thinking" of various sorts. By "open-ended" is meant thinking that normally does not have one right answer determined, e.g., by the rules of physics, algebra, or logic. It involves contexts and judgment calls. For example, it is important to teach for and test for the kind of critical and creative thinking that deals with governmental policies and family problems, with good planning ahead, or with clear and compelling expression in writing and oral communication. The question is, can objective testing be applied to such open-ended thinking?

Certainly the attempt has been made. Many objective tests seek to measure open-ended thinking of various sorts. There are basic approaches: enumerating answers and using a multiple-choice format which has been slightly modified.

Enumerating answers. The most common style of objective test for open-ended thinking is multiple choice. It is also possible to construct a test of open-ended thinking by inviting students to write answers; and then one enumerates in an "answer key" most of the likely answers with associated scores. The scorer then has to cross-check a student's answers against the answers listed in the key. This strategy is used mostly in tests where students themselves are urged to list many possible answers — for example, in tests of creative thinking that emphasize ideational fluency. Students might be asked to list as many different uses for a brick as possible — a classic way of gauging idea-generating abilities. A scoring key might include a long list of possible uses, organized in categories for easy reference. The scorer scores an individual's ideas by counting up how many answers appear on the list and in how many different categories they occur. The latter measures the range of the test-taker's thinking. With a test of this sort, it is not so

official list; the student's list and the official list will almost certainly largely overlap, and that is enough to derive a score.

Multiple-choice testing with reason giving. Another interesting way of combining open-ended thinking with objective methods has been used: a combination of multiple-choice testing, as discussed above, with reason giving. For instance, students might be given the question used earlier about the president of the United States as part of a series of questions. They would be asked to make their best choice. However, each student would also be asked to write beside it one or two reasons for his or her choice. The test is scored conventionally for the "official answer" but the scorer makes adjustments when it appears that a student advances sound reasons for an "unofficial" answer or weak reasons for an "official" one.

These efforts to marry objective testing to open-ended thinking certainly have merit. The multiple-choice design for thinking-oriented questions is as efficient to score as any other multiple-choice test. True, one can sometimes debate the official answers, but one should remember that this can be true for tests that supposedly just test for facts. Moreover, the multiple choice items, if well designed, require the student to do the kind of reasoning being tested in order to arrive at the "official" correct selection.

Caveats. However, there are caveats that have to be recognized. One concerns the "possible answer" and "multiple choice with reasons" variations: the scorer judgment enters more into the picture. A scorer checking student responses against a "possible answer" list often has to judge whether a student's idea corresponds in gist to something on the list, since the student's wording would not generally be identical to that of the key. A scorer appraising a students' written reasons for a choice among alternative answers must judge the soundness of those reasons. Thus, these variations are neither as efficient nor as reliable as straight multiple-choice methods. However, they offer significant efficiency in comparison with truly open-ended scoring situations

such as the evaluation of an essay. These problems of objectivity are not as severe as one might think, as we will discuss later under "interpretive tests."

Another caveat is that all these variations involve significant indirectness. They fall far short of testing the intellectual performances one really wants in their full richness. The multiple-choice format does not capture the whole open-ended process of generating ideas, exploring reasons, devising new approaches, and so on. It tests only for what might be called the *discriminative* side of this process—deciding among given options. As to the "possible answers" format, the brainstorming of answers that students do in such a test is only a part of what in real life is an integrated process of problem solving or creative thinking.

Another problem concerns being sure that students choose the answers they do because they have exercised the skills the test is designed to measure. As we emphasized above, *well designed* test items do not allow loopholes—other ways by which a student might arrive at the official answer. But in fact it is an art to design items without such loopholes and with defensible official answers. Many of these points about the advantages and shortcomings of such tests are elaborated in the third volume of this series.

Again we ask what morals can be drawn from the discussion. Objective tests of open-ended thinking—e.g., the sort of thinking involved in developing informal arguments or in planning—may be good measures if one has not taught to the test. Nor is it even inappropriate to teach *in part* to the test, since tests of this sort can capture part of the relevant performance. However, sound instruction for open-ended thinking should encompass considerably more than these tests measure. Moreover, after instruction that in part teaches to the test, one should then only view the test as measuring that particular aspect of the thinking, not the entire performance. Finally, one must examine the test carefully to see whether

the items are fairly "loophole free," really demanding the sort of thinking they purport to measure.

Tests of intelligence

There is no question that intelligence tests have a very mixed reputation among educators and parents. Such tests are often thought to be culturally biased, overly academic, and irrelevant to "real world" thinking. Nor are these concerns entirely unwarranted, as we discussed in chapter 1. Nonetheless, it is natural to wonder whether intelligence tests might offer a useful measure of the impact of efforts to teach thinking. Moreover, certain of the prominent programs commercially available today have in fact been evaluated in part through standardized intelligence tests. Consequently, it is important to examine their relevance.

Tests of intelligence embody the notion that there is a pervasive trait, "intelligence," that equips a person to handle more or less well a number of rather different sorts of problems. This premise is by no means a fantasy. When one asks a group of individuals to solve a variety of different problems, one almost invariably finds that those who do better at one type of problem also tend to do better at the others. Given such results, it is natural to posit that the overall quality of the performance reflects that the person tested has more or less of some one or several underlying capacities. It is this general factor that intelligence tests seek to measure. Also, because of the impact such underlying capacities have on thinking of diverse sorts, it is natural to hope that efforts to improve students' thinking will show results on intelligence tests.

What are intelligence tests like? Almost invariably they are objective. Typically, an intelligence test poses a range of varied tasks of a puzzle-like nature. The variety allows for the fact that individuals will bring distinctive talents and experiences to one or another of the subtests; by having several subtests, one can average out scores and derive a purer measure of the crosscutting factor that is intelligence. The items are puzzle like, but of a sort not usually encountered in everyday life, in an effort to filter out

somewhat the influence of knowledge and experience. A typical kind of item asks students to determine an analogy between a given pair of things and some other set chosen from among a number of such sets. For example:

> Hat is to head as roof is to:
>
> (1) shingle; (2) house; (3) nail; (4) carpenter

If one used instead a history test, for example, people's performances would depend too much on accidents of individual experience, such as whether one had had a recent history course. If one used crossword puzzles, that would favor *aficionados* of such puzzles. Intelligence tests are supposed to measure not what facts people know or what specialized skills they have, but how well in general they can use their minds.

Let us accept for a moment this ideal picture of what an intelligence test is supposed to measure and how it measures. Even the ideal picture implies some cautions for instruction and evaluation of thinking. By its very concept and construction, an intelligence test only samples restricted aspects of thinking in order to get at the underlying trait of intelligence. That is, an intelligence test is deliberately indirect in that it makes no pretense of covering any kind of thinking. Moreover, an intelligence test depends for sound design partly on the relative unfamiliarity of test-takers with the kinds of items used. If a test-taker has had extensive experience with a particular kind of item, he or she brings to the intelligence test a context-specific familiarity and skill that is out of keeping with the goal of intelligence tests.

Intelligence tests are meant to gauge a crosscutting underlying trait that determines a general level of performance independent of learning. Therefore, teaching to intelligence tests in an effort to improve thinking is a mistake, both because such tests are by design indirect and because for their own validity they assume the relative unfamiliarity of test-takers with the kind of item. Notice that neither of these concerns reflects negatively upon the concept of IQ or the soundness of intelligence tests. Both concerns warn,

Table 10.1. Cautions for Using Intelligence Tests to Evaluate Thinking

Intelligence Tests:

1. only sample restricted aspects of thinking;
2. are deliberately indirect and do not cover comprehensively any kind of thinking;
3. depend in part for sound design on the relative unfamiliarity of test-takers with the kind of items used;
4. are meant to gauge a crosscutting, underlying trait;
5. fail in their range of items to encompass many realms of human performance;
6. bear in their scores a limited relation to success in real-life contexts within a discipline.

rather, that careless use can pervert what may be perfectly adequate measures of intelligence.

A second round of cautions concerns the notion of intelligence itself as it has been developed through testing. Some of these points were made in chapter 1, but they bear repeating here. First of all, while in principle intelligence is supposed to be a crosscutting capacity, in practice the range of items on a typical intelligence test fails to encompass many realms of human performance: the kind of inventiveness displayed by a creative artist or scientist, the sensitivity to language of a poet, the ambition of a politician or actor, the bodily awareness of a dancer. In short, if there really is a crosscutting capacity, one ought to cast a wider net to find it. To

be sure, some less known efforts to test intelligence view it as composed of a number of subtraits and try to measure these independently. Unfortunately, even the subtests of such eclectic theories do not range all that widely.

Another caution concerns the predictive value of intelligence tests. Scores on such tests do relate considerably to academic performance, but they seem to bear little relation to success in real-life contexts within a discipline. That is, given that one has become a salesperson or a physicist, how intelligent one is does not seem to have much to do with how well one does. This warns that intelligence tests omit to measure important aspects of what one needs to manage well in real-life situations. Perhaps the best way to sum up both these cautions is this: in principle an intelligence test is supposed to discern and measure an underlying trait that cuts across virtually all mindful human performances; in fact, existing intelligence tests do not really succeed in this mission. This could be attributed to the fact that either these tests do not encompass a wide enough range of tasks, or that intelligence is diverse rather than unitary, or both.

What conclusions can be drawn regarding the use of intelligence tests to evaluate efforts to teach thinking? First of all, do not teach to the test. This runs contrary to the very design of intelligence tests. Second, one can use intelligence tests as pretests and posttests to measure an ability or cluster of abilities related to academic performance. Certainly, better academic performance is one laudable target for efforts to develop thinking, and intelligence tests can help with evaluation in this area. However, it should not be supposed that anything broader than a certain range of academic ability is being measured. Finally, one probably should not use intelligence tests as the only measure of improvement in academic thinking, since there may be many aspects of academic skill that would not show up on intelligence scores.

Section Summary

This concludes our commentary on objective tests. Two general points should be clear from the discussion. First of all, objective tests certainly have a significant place in the summative evaluation of approaches to improving students' thinking. But second, there is a recurrent problem of indirectness. Objective tests in general do not measure more than a part of whatever kind of thinking with which one is concerned. Depending on the size of that part and other factors, it may or may not be appropriate to teach to the test. It is virtually never appropriate to teach only or mostly to the test. Approaches teaching mostly to an objective test run a serious risk of justifying themselves through a self-fulfilling prophecy that has but limited bearing on genuine thinking of the sort the approach is supposed to develop.

Section Two: Interpretive Tests

Another testing option—one that contrasts with objective tests— deserves exploration. These tests require for scoring the seasoned judgment of one or more individuals familiar with the topic. Instruments of this type are less concerned with the problems of efficiency and scores independent of scorer addressed by objective tests. They seek to come closer to the sorts of holistic thinking performances that are the real objectives of efforts to develop students' thinking. For instance, an interpretive test might ask students for a reading of an unfamiliar poem, challenge them to develop a simple explanation for a physical phenomenon, invite them to argue an issue not previously discussed in class, or pose the puzzle of redesigning the human hand for greater efficiency. Any of these questions could engage students in extended episodes of authentic thinking.

Tests of this sort are very familiar. They are the bread and butter of much classroom practice. Teachers give essay tests, collect the essays, and go through each response in turn, evaluating the quality of the thinking and other factors. The tests recommend themselves for individualized use in classroom settings to gauge the quality of student thinking. However, when the aim is to

evaluate systematically the impact of an approach to the teaching of thinking, simply writing comments on student papers or assigning an overall grade typically is not enough. It is necessary to pursue somewhat more elaborate approaches to scoring.

There is a dilemma about what to call testing of this sort. One could speak of nonobjective or even subjective tests. But these terms imply that such testing gives up all aspirations of dealing with scorer idiosyncrasy. This is not the case. Indeed, when proper methodology is employed, considerable pains are taken to achieve scores independent of scorer bias. This is accomplished by having more than a single person score at least some of the tests and by preserving only those dimensions of scoring on which the scorers agree fairly well. Accordingly, for purposes of this discussion, we choose the term "interpretive tests" to underscore the point that such tests require a scorer's interpretation. They are not, however, necessarily thereby subject to the idiosyncrasies of a particular scorer.

As with objective testing, it is useful to review interpretive tests according to the general characteristics of evaluation introduced earlier:

- the purpose of an evaluation based on interpretive tests can be either summative or formative;
- one should not think that because interpretive tests are "softer," they are less suited to summative evaluation;
- there is a well-established methodology for rigorously conducting interpretive testing, and summative evaluation results based on interpretive testing are entirely acceptable;
- the data for interpretive as well as objective tests is obtained by administering the instrument to the students;
- the focus, however, can be on evaluating approaches as well as individual students; and

- like an objective test, an interpretive test administered before or after instruction does not stand very close to the instructional process. Hence, they can expose a student's thinking in ways that straightforward objective tests cannot.

Interpretive tests contrast most sharply with objective tests on the attributes tested. Free from the constraints of objective testing, interpretive tests can pose holistic tasks to students. These, as we emphasized earlier, engage them directly in the kind of thinking one wants to develop. For instance, if one seeks to develop students' ability to construct and assess arguments, one can test the students by asking them to write an argument on an issue or to critique another's argument on an issue. A good example of a test that does the latter, The Ennis-Weir Critical Thinking Essay Test (1985), is discussed in volume 3 of this series, *Evaluating Critical Thinking*. If one seeks to enhance students' creative thinking in every-day contexts, one can pose everyday problems and ask the students to write out possible solutions, their rationales, and their final choice with details on its implementation.

It is particularly important to emphasize here that subject matters that usually are the sole province of objective testing in fact invite interpretive testing as well. For example, a typical objective test question about the basic machines—lever, wheel, and so on—might involve calculating the mechanical advantage of a given lever. An interpretive question might take this form:

> Consider a screwdriver. Identify all the basic machines involved in its typical uses. Do any calculations appropriate to illustrating its mechanical advantages, assuming plausible values for any dimensions needed.

Evidently such a question cuts much closer to the real use of physics concepts in understanding the world than does the typical objective test question. However, evaluating students' responses certainly calls for interpretation.

Any follow-up example used for teaching for transfer (see chapter 7) can be used to test a thinking skill or activity. Here is one from a lesson on determining the accuracy and reliability of observation (Schraer and Stolze, 1987):

> Suppose you were interested in gathering information about the natural behavior of various animals that live in and around a pond. What steps would you take to make sure that you get accurate observational reports?

Given as a pretest to students who have not been instructed on this skill, it often reveals very fuzzy and nonsystematic thinking. Some responses are:

> I would plan to look at things.
>
> I would go there.

When this is given as a posttest after a lesson and suitable reinforcement on determining the accuracy of observations, students say things like:

> I would bring binoculars.
>
> I would make sure I could get close enough to get a good view.
>
> It would have to be daylight.
>
> I would read up on what I was going to be observing beforehand so I knew what I was going to be looking at.
>
> I would bring a pad and pencil and write down what I saw when it was happening.
>
> I would bring someone along who would also take note of these things.

This gets at factors such as expertise, proximity to what is being observed, good observation conditions, record keeping, the use of observation-enhancing instruments, etc., all of which are factors students learn to attend to through instruction in the skill. Notice how the term "observation" is a cue word in this test.

It could be omitted if you also wanted to find out whether the students identified this situation as one calling for the use of this skill.

Such tests are easy to make up. Any example that can be used to teach for transfer will do. Here, as in lesson construction, your ability to detect good answers depends upon your having a clear understanding of the skill you want to teach. This can be achieved through the construction and use of thinking maps like the ones we discussed in chapters 4 and 7. For the classroom teacher such maps turn out to be the cornerstone of good lesson design; they also provide the basis for an ability to detect a good answer on interpretive tests of thinking skills.

The exact character of an interpretive test can, of course, vary considerably. It may call for:

- extended writing or oral comment;
- lists of alternative responses to open-ended questions with brief comments on each;
- short, to-the-point answers to a number of questions demanding some thought; and
- "performance testing."

One interesting variant, which is listed above, sometimes called "performance testing," involves engaging students in some task. This, for example, could be doing an experiment and observing and appraising what students do in the process rather than basing scoring on final outcomes. There are many other possibilities. However, since the spirit of the enterprise is much the same, there is no need to discuss a variety of subtypes of interpretive tests as we did for objective tests. Instead, we turn now to examine several natural questions about the effective use of interpretive testing.

Getting out numbers

It is easy to extract numbers from objective tests; one need only tally the correct answers. Less obvious are tactics for deriving numbers from students' responses to interpretive test items. Yet the need is no less great as far as summative evaluation is concerned, especially when an approach to teaching thinking is being evaluated. One requires a formal numerical basis for comparison with pretests or control group performance or both. How can this be accomplished?

The two most convenient procedures are counts and holistic rating scales.

Definition: Counts are tallies of the number of events in a particular test response.

Examples:

1. One might count the number of "pro" reasons and the number of "con" reasons offered by students developing an argument on an issue.
2. One might count the number of basic machines mentioned by a student writing about a screwdriver in the problem mentioned earlier.
3. For an elementary measure of elaborateness of response, one might even simply count the number of sentences in a written answer.

Definition: Rating scales are reminiscent of grading. However, instead of calling for an overall grade that may take into account penmanship as well as thinking, they require the scorer to rate a student's response or some part of it on a particular dimension.

Examples:

1. For a relatively fine-grained analysis of a student's argument, a scorer might rate each individual reason on a scale like this:
   (1) negligible;
   (2) weak;

(3) medium;

(4) telling;

(5) compelling.

2. Or one might use the same scale for a student's entire argument. For the screwdriver problem, one might use a scale something like this for a student's whole response:

(1) no ideas;

(2) one or two ideas undeveloped;

(3) one or more ideas with considerable development;

(4) nearly all relevant machines identified with considerable development;

(5) nearly all, with considerable development and nearly all math done correctly.

The easiest way to launch an interpretive evaluation is to employ professionally prepared instruments that come with the rating scales already defined and a scoring manual that explains how to conduct the scoring process. Unfortunately, there are not nearly as many commercially available interpretive as objective tests.

A feasible alternative is to construct one's own interpretive test and rating scales. Table 10.1 presents a list of important general points to observe when constructing such rating scales. We would note regarding point 7 that typically before and during the first phases of scoring, there is a period of considerable refinement. One always finds cases one did not anticipate where one needs to set interpretive policies and refer back to them as needed.

If a person has never set up and carried through an interpretive scoring system before, it may well be a good idea to seek some professional guidance. The enterprise is not terribly difficult, but there is a need to approach the matter systematically, with an eye out for hazards of unnecessarily fuzzy rating scales. Most of all, there is a problem of courage. At the outset, the categories can seem woefully vague, the students' responses full of exceptions

Table10.2. General Points to Observe in Constructing a Rating Scale for One's Own Interpretive Test

1. It is a mistake to have too many levels in such rating scales: 3 to 7 serves well.
2. It is usally preferable to use multiple scales, not just one overall rating. (That provides several different windows onto the performance in question.)
3. Typically, think carefully about the performance in question and survey some sample student performances. This gives a sense for the kind of discriminations one might want to make and be able to make reasonably well. Use a thinking map (chapter 7).
4. Avoid trying to establish a scoring system that captures everything that is going on.
5. Responses to interpretive test items can be extremely rich; one needs to decide what dimensions one wants to score for one's evaluative purpose and avoid becoming mired in an effort to be perfectly encompassing.
6. Before and during the first phases of scoring, there is a period of considerable refinement.
7. One should keep a list of policies and refer back to them as needed.

and borderline cases. Nearly always such dilemmas can be sorted out, but the moral and advisory support of someone who has been through the process can be important.

Reliability in interpretive scoring

The principal worry people have about interpretive scoring concerns its subjectivity. Might not different scorers, using interpretive scoring, assign different ratings to the tests? Especially as

the scoring moves away from counts and toward somewhat holistic scales such as those illustrated earlier, the hazards of rampant subjectivity seem to loom large.

Perhaps the single most important point to make about interpretive scoring is that reliability is not nearly as much of a problem as one might think. Despite the holistic nature and seeming vagueness of some of the scoring criteria, actually it is rather easy to get substantial agreement between two scorers working independently. That agreement in itself constitutes evidence that the scorers are getting at something objective, although not by way of the official-right-answer criterion laid down for an objective test.

To be sure, sometimes on a particular count or rating scale one does not achieve the agreement one would like to see. In that case, it is best to discard the count or scale. However, this does not happen very frequently. Moreover, if one follows the practice recommended earlier of approaching the scoring of an interpretive test with several counts and scales at once, one always ends up with plenty of measures to ponder even if a couple have to be discarded for methodological reasons.

Of course, achieving adequate agreement between two scorers requires some effort. On sample data or at the beginning of the official scoring, the two scorers should score a little bit and then compare notes. This would involve discussing disagreements, deciding whether they simply represent divergences in a "judgment call," and if not, establishing and writing down policies to resolve similar cases in the future. The scorers can settle particular scores by discussion, but they should not erase the original scores they arrived at independently since these can be important data to use later for calculating interjudge agreement. It may take several rounds of scoring, comparison, and discussion before the scorers agree fairly well most of the time.

Achieving considerable agreement does not end the matter of reliability. As the scoring continues, the scorers should compare from time to time how they score the same item in order to stay in

Table 10.3. Achieving Reliability in Interpretive Scoring

1. On sample data or at the beginning of the official scoring, the two scorers should score a little and then compare notes.
2. It may take several rounds of scoring, comparison, and discussion before the scorers agree fairly well most of the time.
3. As the scoring continues, the scorers should compare from time to time how they score the same item. Without occasional comparison, scorers tend to drift apart.
4. To measure counts and rating, use a "correlation coefficient" to determine whether the scorers are scoring closely with one another.

basic accord with one another. Moreover, the scorers should not know in advance but should choose randomly what tests they compare. Otherwise each might try to take special care only with those tests on which they anticipate comparative discussion. Without occasional comparison, scorers tend to drift apart, so it is important to continue this practice.

Finally, how ought one to measure interscorer agreement? For counts and ratings the most convenient measure is a statistical index called a "correlation coefficient" calculated between the scores of the two scorers. The correlation coefficient measures the extent to which the scorers are scoring in unison with one another. For a high coefficient, it is not necessary that the scorers exactly agree all the time, but only that they be close to one another. For instance, suppose the scorers are scoring on a 5-point rating scale. If, when one scorer chooses 5, the other usually chooses either 4

or 5 and if this occurs with other points on the scale, then the correlation coefficient will be quite high and very statistically respectable. Details on the statistics appropriate to such comparisons and their interpretation would be out of place here, but the matter is not in fact terribly technical.

The efficiency of interpretive scoring

The other great concern about interpretive scoring is its supposed inefficiency. Images arise of scorers pouring for hours over each individual test. Such fears fuel the impetus to use objective tests even though they may suffer from problems of indirectness.

As with the concern about scorer independence, the concern with efficiency is legitimate but somewhat inflated. With a judicious choice of counts and scales and some practice, one can become quite adept. For example, scoring a two-page essay on several counts and scales need take no more than five minutes or so. To be sure, this is not as rapid as feeding a form to a computer or using an overlay with holes in it to check the correctness of multiple-choice responses. But the process is nonetheless fairly brisk.

Another source of inefficiency in interpretive scoring comes from the use of two scorers. Objective tests need only be scored by one scorer. It is imperative, however, to take seriously the possible divergence of judgment calls and involve at least two scorers in a process of interpretive scoring for summative evaluation when we are evaluating a program or a specific approach to teaching thinking. (One can be somewhat more casual if one uses interpretive tests for formative evaluation or to evaluate how well individual students may have grasped specific thinking skills that have been taught).

Again, however, matters are better than they seem at first. It is not really necessary on a large data set for two scorers to score every test. The two scorers may only co-score a subset—say 20 percent—of the tests. There are two different ways of managing this. Sometimes, one scorer scores everything, with a second scorer independently scoring a subset as a check. Or the two scorers can divide up the data, each scoring somewhat more than

half to allow for some overlap. The only caution is that the scorers should not decide in advance exactly which tests they will co-score: They should be chosen at random during the process. Otherwise, the scorers might exercise more care with those tests where they expect comparison, and consequently the calculation of interscorer agreement could be spuriously high.

One more testing context deserves special comment here: state-wide testing programs. Those who implement many of these feel pressed to use only objective tests in gauging progress in the teaching of thinking (or other matters) across the state. The individuals involved feel that only objective tests will allow the needed efficiency, even though they acknowledge the risks of indirectness in testing. We recommend that in such contexts the use of some interpretive testing be considered. The belief that efficiency disallows interpretive testing on a state scale causes evaluators to make the mistake of neglecting the powers of partial sampling. There is no particular reason why every student in every school must be measured. By partial sampling, one can reduce drastically the number of tests collected in a way that is statistically legitimate. Consequently, the amount of time available to score any one test is increased. Even if one wants some information from every school, one need not have information from every student. Given proper technical planning of sampling needs, the reduction in the number of tests administered can be drastic and with little loss of real information.

Teaching to an interpretive test

Finally, we turn to the issue of teaching to an interpretive test. It will be recalled that teaching to an objective test is risky because objective tests almost invariably measure somewhat indirectly the performance one really wants. Perhaps, for example, they only measure its discriminative but not its generative aspect; or perhaps its convergent but not its divergent aspect. Indeed, perhaps the performances measured are simply correlates with no direct logical connection to what one really wants to measure.

None of these arguments need apply to a well-designed interpretive test. Of course, bad test design is always a risk. One certainly can make up a holistic task designed to engage critical thinking, creative problem solving, or judicious planning that does a bad job of invoking students' abilities in these areas. Nonetheless, without the constraints of objective tests, on the whole it is rather easy to make up rich tasks for students to perform on these tests that have high face validity for tapping rich domains of thinking.

With this in mind, teaching to an interpretive test often is highly desirable. Teaching directly does not, of course, mean anticipating the very items on the test—the same literal questions. But it can legitimately mean teaching directly to the holistic performances the test gauges. Imagine, for example, that we want to develop students' ability to write analytical essays. So we teach strategies of analytical essay writing, and we test by asking the students to write analytical essays. This is teaching to the test, to be sure, but teaching to a test that consists of the performance one really wants. Teaching to the test is only a hazard when the test does not measure what one really wants to develop.

How to Proceed

In this chapter we have explored a number of factors bearing on evaluation and efforts to teach thinking. The landscape may now seem a little bewildering since evaluation, although not terribly complicated, is not terribly simple either. A number of decision points confront the teacher or administrator ready to face the problems evaluation poses. We conclude the chapter with a rough map of how one might navigate through these choice points.

Finding your goals. Perhaps the first question to ask oneself in beginning to ponder the prospect of evaluation is, *Where are we now?*

Q. Are approaches just being considered?

A. That calls for the kind of thinking reviewed under the heading *design evaluation*.

Q. Is an approach being put into practice for the first time?

A. Formative evaluation, with its associated tactics, is almost certainly called for in that case.

Q. Or has an approach undergone enough trials so that at least superficially it proceeds fairly smoothly?

A. In that case, *summative evaluation* will provide the basis for thoughtful decision making. With it one can determine whether to continue the approach, how widely, and with what needed revisions.

Q. People pondering a summative evaluation must also ask, Considering our resources, should we attempt a *formal* summative evaluation with all its technicalities? Or would it be preferable to develop an informal summative evaluation?

A. The latter is much more manageable for the teacher working alone.

Yoked to these major matters of purpose are implied answers to other questions we introduced earlier to help us characterize an evaluation.

Q. On what are we gathering data?

A. In the case of design evaluation, on whatever one can hear or read about the approach.

In the case of formative evaluation, on the teaching, the classroom ambience, the students' responsiveness, their performance on seatwork, and the like.

In the case of summative evaluation, principally on student performance .

Q. What is the thing being evaluated? An approach? Individual students? A school-system-wide master plan?

A. We have focused this discussion on evaluation of approaches, which is probably the single most important concern as schools strive to develop or adopt approaches to the teaching of thinking. At the same time, similar considerations of evaluation also apply when one is seeking, for example, to evaluate individual students or school system plans.

Q. How close is the evaluation to the actual instructional process?

A. In the case of formative evaluation, quite close—day by day, hour by hour.

In the case of design evaluation, perhaps only lesson by lesson.

In the case of summative evaluation, considerably more distanced. In summative evaluation particularly, one needs to consider the possibility of delayed tests and tests of transfer to gauge whether one is getting the ultimate results one wants."

Finding your instruments. Having sorted out the matters above, one needs then to decide on techniques of measurement suited to the situation. Formative evaluation invites a mix of classroom observation and objective and interpretive tests. It is important, however, not to invest too much effort in the testing or take results as more definitive than the "shakedown" nature of formative evaluation allows. One can buy instruments or design one's own.

More important than anything else is the match between the objectives of the instruction and the instruments chosen. The closer the taking of the test matches the performance one ultimately desires the better. The principal risk in testing is indirectness. Objective tests always involve some indirectness. At best they sample only a part of the performance in which one is really interested, and at worst they have only a statistical relationship to it rather than genuinely sampling it at all. It is often easy to design interpretive tests that capture the performance one is really interested in. One has to go on, however, to evolve reasonable ways of scoring performance that yield numbers, even for an informal summative evaluation; this also is not terribly difficult. Finally, if a formal summative evaluation is chosen that involves interpretive tests, one also has to allow for multiple scorers and interscorer comparisons to ensure reliability. Again, readers are referred to volume 3 in this series for additional information.

Designing an evaluation plan. Having decided upon a testing instrument, one must then decide whom to test and when to test them.

Q. In a formal summative evaluation, is there a need for a control group?

A. Often, but only if one can expect students to improve somewhat on the performance in question simply in consequence of normal instruction or maturation during the period of the special instruction.

Q. Is a pretest as well as a posttest needed?

A. Often, but only if one can expect that many of the students already may display a significant amount of skill with the kind of thinking one seeks to develop.

Q. Does one have the resources to test not only for immediate results, but with a delay, and with transfer tasks?

A. This is extra effort, but it is worth it, especially if one already is convinced that the instruction has an impact on immediate posttests. Such additional data is relevant to the ultimate goal of the instruction: the assimilation of the kinds of thinking we are teaching into the lives of our students.

In an informal summative evaluation, one pares down the paraphernalia of control groups, pretesting, and so on, to the minimum, including an element only if it appears absolutely crucial to meaningful results.

Getting help. Formal summative evaluation particularly is a semitechnical enterprise. We encourage teachers and administrators to take seriously the challenge of formal summative evaluation because underevaluation is a serious problem in the current wave of interest in developing students' thinking. At the same time, outside help may have to be sought in some aspects of methodology unless a school system happens to have an in-house person skilled in such matters. Typical issues that might benefit from counsel include:

- how many students to involve in an experiment to ensure statistically meaningful results;
- what kinds of statistical operations to perform on test results;
- the interpretation of levels of statistical significance;
- the design of scoring systems appropriate for interpretive tests; and
- the calculation of levels of interscorer agreement for such tests.

While acknowledging the need for help in such technical matters, we should recall again the option of an informal summative evaluation. Such an evaluation can be quite informative (despite its risks of error) when resources do not allow a formal summative evaluation. However, the possibility of a formal summative evaluation should not be dismissed. The level of sophistication needed for a respectable formal summative evaluation is not extremely high. Consultation with a local university faculty member or some other qualified individual should generally provide most of the technical counsel that is needed. Moreover, many teachers or school administrators who have received masters degrees will have taken sufficient statistics and methodology courses about test instruments if they care to resurrect them. Science and math teachers will often find they have ample background to master the necessary technicalities if they have the time and interest. Many school systems have microcomputers, and a number of statistical packages are now available for microcomputers that have ample power to analyze the data from typical summative evaluations.

On the one hand, some expert counsel may be called for and it is reassuring to consider that this should neither be very expensive nor very hard to find. On the other, the needed expertise is not so advanced but that one may well be able to locate it in-house. Consequently, we encourage school administrators seriously interested in the successful teaching of thinking to support their teachers' efforts by providing the personnel and expertise needed for formal summative evaluations. This can be achieved through

release time and outside counsel. The beneficial results will be better local decision making and a growing pool of experience from school to school about effective ways of teaching thinking.

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